

Record of Decision

Lockwood Solvent Groundwater Plume Site

Billings, Montana



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Helena, Montana 59620



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EPA Superfund
Record of Decision

LOCKWOOD SOLVENT GROUNDWATER PLUME SITE
EPA ID: MT0007623052
BILLINGS, MT
August 17, 2005

RECORD OF DECISION

LOCKWOOD SOLVENT GROUNDWATER PLUME SITE, MONTANA

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ACRONYMS

ARAR	Applicable or Relevant and Appropriate Requirements
ATSDR	Agency for Toxic Substances and Disease Registry
Beall	Beall Trailers, Inc.
Brenntag	Brenntag West, Inc.
CDI	Chronic daily intake
CECRA	Montana Comprehensive Environmental Cleanup and Responsibility Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
cis-1,2-DCE	cis-1,2-dichloroethene
DCE	Dichloroethene
DEQ	Montana Department of Environmental Quality
DNRC	Montana Department of Natural Resources and Conservation
EPA	U.S. Environmental Protection Agency
HI	Hazard index
HQ	Hazard quotient
IRIS	Integrated Risk Information System
LSGPS	Lockwood Solvent Groundwater Plume Site
MCL	Maximum contaminant level
mg/kg-day	Milligrams per kilogram per day
mg/L	Milligrams per liter
mg/m ³	Milligrams per cubic meter
NAPL	Non-aqueous phase liquids
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
ORD	EPA's Office of Research and Development
PCE	Tetrachloroethene
PVC	Polyvinyl chloride
RACER	Remedial Action Cost Engineering and Requirements
RfD	Reference dose
SF	Slope factor
STSC	EPA's National Center for Environmental Assessment/Superfund Technical Health Risk Support Center
TCE	Trichloroethene
TtEMI	Tetra Tech EM Inc.
µg/L	Micrograms per liter
USGS	U.S. Geological Survey
VC	Vinyl chloride
VOC	Volatile organic compound

PART 1

DECLARATION

Site Name and Location

Lockwood Solvent Groundwater Plume Site (LSGPS)
Yellowstone County
Billings, Montana
EPA (CERCLIS) ID#: MT0007623052

Statement of Basis and Purpose

This decision document presents the Selected Remedy for the Lockwood Solvent Groundwater Plume Site, in Billings, Montana. The State of Montana Department of Environmental Quality (DEQ) and the United States Environmental Protection Agency (EPA) chose the Selected Remedy in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended by the Superfund Amendments and Reauthorization Act of 1986, and in accordance with Montana's Comprehensive Environmental Cleanup and Responsibility Act (CECRA). To the extent practicable, the Selected Remedy is also in accordance with the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). DEQ and EPA based this decision on the Administrative Record file for the LSGPS. EPA has consulted with DEQ throughout conduct of the RI/FS, the development of the Proposed Remedial Action Plan (Proposed Plan) (DEQ 2004), and in selection of the remedy. EPA concurs with this remedy and adopts this Record of Decision.

Assessment of the Site

The response action selected in this Record of Decision is necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances, pollutants, or contaminants into the environment.

Description of the Selected Remedy

The Selected Remedy is a comprehensive approach for the remediation of groundwater and subsurface soil contaminated with chlorinated solvents. The two main source areas constituting principal threats are continuing sources of contamination to the site-wide groundwater. Previous investigations by DEQ, EPA, and others identified two source areas with elevated concentrations of contaminants in soil and associated groundwater: the Beall Trailers Inc. (Beall) and Brenntag West Inc. (Brenntag) properties. Focused remediation at the source areas will address the principal threat wastes posed by the site. Contaminated soils in these source areas will be treated to prevent further groundwater contamination. Contaminated groundwater will be contained to prevent further migration and treated to reduce contaminant concentrations. The following list summarizes the Selected Remedy components which are discussed in detail in Part 2, Section 9.

Major components:

Site-Wide Elements

- Long-Term Groundwater Monitoring

- 5-year CERCLA reviews

- Institutional controls

 - Controlled Groundwater Area

 - Deed Notices/Deed Restrictions

 - Community Awareness/Education

- Risk Mitigation Measures

 - Continued potable well(s) groundwater monitoring and mitigation measures

 - Indoor air monitoring and mitigation measures

Beall Source Area Groundwater and Plume Leading Edge

Treat with enhanced bioremediation

Beall Source Area Soil

Treat vadose soil with soil vapor extraction

Brenntag Source Area Groundwater

Contain and treat with a permeable reactive barrier (or other treatment/containment barrier technology determined by DEQ and EPA during Remedial Design to be equally effective in achieving performance criteria as set forth in this Record of Decision)

Treat with enhanced bioremediation

Brenntag Source Area Soil

Excavate accessible vadose zone soil and accessible fine-grain saturated zone soil and thermally treat on-site

Treat inaccessible vadose soil with soil vapor extraction

Treat inaccessible saturated zone soil with chemical oxidation

Site-Wide Groundwater

Treat with enhanced bioremediation followed by monitored natural attenuation

A remediation goal of 5 micrograms per liter ($\mu\text{g/L}$) for tetrachloroethene (PCE), and trichloroethene (TCE), 70 $\mu\text{g/L}$ for cis-1,2-dichloroethene (cis-1,2-DCE), and 2 $\mu\text{g/L}$ for vinyl chloride (VC) in groundwater will meet the maximum contaminant level (MCL¹) for these contaminants under the Safe Drinking Water Act. Table 1 summarizes groundwater remediation goals. Table 2 identifies site-specific remediation goals for these contaminants in soil that will prevent or minimize further migration of contaminants from soil to groundwater. Part 2, Section 3.4.2.2 details the development of site-specific soil screening levels.

In 2002, EPA's Emergency Removal Program extended the public water supply, conducted indoor air sampling, provided mitigation for indoor air contamination, and continued groundwater monitoring. The purpose of the Selected Remedy identified in this Record of Decision is to remediate contaminated soil and groundwater.

Statutory Determinations

The Selected Remedy is protective of human health and the environment, complies with Federal and State requirements that are applicable or relevant and appropriate to the Remedial Action, is cost-effective, and utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable.

The Selected Remedy also satisfies the statutory preference for treatment as a principal element of the remedy (reduces the toxicity, mobility, or volume of hazardous substances as a principal element through treatment).

Because the Selected Remedy will result in hazardous substances, pollutants, or contaminants remaining on-site above levels that allow for unlimited use and unrestricted exposure, DEQ and EPA will conduct a statutory review within five years after initiation of Remedial Action to ensure that the remedy is, or will be, protective of human health and the environment.

¹ MCL – The maximum contaminant level (MCL) is the maximum permissible level of a contaminant in water that is delivered to any user of a public water system.

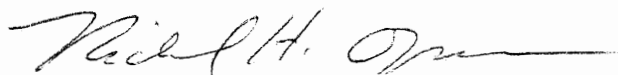
Record of Decision Data Certification Checklist

The Decision Summary section of this Record of Decision includes the following information. The Administrative Record file contains additional information for this site.

- Contaminants of concern identified and their respective concentrations. (Part 2, Section 3.4)
- Baseline risk represented by the contaminants of concern. (Part 2, Section 4)
- Cleanup levels established for contaminants of concern and the basis for these levels. (Part 2, Section 3.4)
- Principal threats addressed through treatment. (Part 2, Section 8)
- Current and reasonably anticipated future land use assumptions and current and potential future beneficial uses of groundwater used in the Baseline Risk Assessment and Record of Decision. (Part 2, Section 4)
- Potential land and groundwater use expected as a result of the Selected Remedy. (Part 2, Section 3.4)
- Estimated capital, annual operation and maintenance, and total present worth costs, discount rate, and the number of years over which the remedy cost estimates are projected. (Part 2, Section 9)
- Key factor(s) explained leading to the Selected Remedy (describe how the Selected Remedy provides the best balance of tradeoffs with respect to the balancing and modifying criteria, highlighting criteria key to the decision). (Part 2, Section 9)

Authorizing Signatures and Support Agency Acceptance of Remedy

DEQ, as the Lead Agency for the Lockwood Solvent Groundwater Plume Site (MT0007623052), formally issues this Record of Decision.



8/16/05

Richard H. Oppen, Director
State of Montana
Department of Environmental Quality

Date

EPA, as the Supporting Agency for the Lockwood Solvent Groundwater Plume Site (MT0007623052), formally concurs and adopts this Record of Decision.



8/16/05

Max H. Dodson
Assistant Regional Administrator
Ecosystems Protection and Remediation
EPA Region 8

Date

PART 2

DECISION SUMMARY

SECTION 1

SITE NAME, LOCATION, AND DESCRIPTION

The Lockwood Solvent Groundwater Plume Site (LSGPS), CERCLIS ID# MT0007623052, is a 580-acre site on the outskirts of Billings, in Yellowstone County, Montana, that has been found to have chlorinated solvent contamination in soil and groundwater. Current land use within the LSGPS is characterized as residential, commercial, and "light" industrial. Examples of commercial and light industrial businesses in the area include trucking, vehicle repair, truck tank manufacturing, chemical repackaging, machine shops, and auto salvage. At this time, the primary source of domestic use water in the LSGPS is from the Lockwood Water and Sewer District Public Water Supply. However, some full-use domestic, other domestic (such as irrigation), commercial, and nondomestic use water is known to come from the shallow alluvial aquifer via several individual wells. Previous investigations by DEQ, EPA, and others indicate chlorinated solvents at the LSGPS have adversely affected groundwater, surface water, soil, soil vapor, and indoor air. Figures 1 and 2 show the site location and the site vicinity. The primary contaminants of concern are the volatile organic compounds PCE, TCE, cis-1,2-DCE, and VC. On December 1, 2000, EPA placed the LSGPS on the National Priorities List. DEQ is the technical lead and EPA is the enforcement lead for the LSGPS. The Superfund trust fund has financed the activities at the site to date.

SECTION 2

SITE HISTORY AND ENFORCEMENT ACTIVITIES

2.1 History of Site Activities

Beall manufactures and repairs tanker truck trailers, primarily to transport asphalt. From 1978 to 1990, trailers were cleaned with a solution of dissolved TCE and steam prior to maintenance and/or repair. The wastewater from the steam clean bay was discharged to a septic system and drain field.

Brenntag (formerly hci Dyce Chemical) is a chemical re-packaging and distribution company. Under previous owners, the property was developed and operations began in 1972. Historic releases of what are believed to be PCE and possibly TCE, as well as petroleum products and other organic compounds, characterize the Brenntag Source Area.

2.2 Enforcement Activities

On December 16, 1999, EPA issued the first Request for Information letters to Beall and hci Dyce Chemical pursuant to Section 104(e)(2) of CERCLA. EPA then issued a follow-up Request for Information letters to Beall and hci Dyce Chemical on May 25, 2000. The information requests included questions regarding ownership history, locations of historical and current facilities, retention basins, chemical storage areas, all operations involving hazardous chemicals, waste generation and disposal practices, trade name and quantities of chemical products used, and all leaks, spills or releases. On August 23, 2000, EPA issued letters of General Notice of Potential Superfund Liability to Beall and hci Dyce Chemical. General notice letters notify the recipients of their potential liability under Section 107(a) of CERCLA. Liability includes responsibility for all costs incurred by the government in responding to any release or threatened release at the LSGPS as well as natural resource damages. Subsequent to the issuance of this Record of Decision, EPA will initiate negotiations for implementation of the Selected Remedy.

2.3 Investigation History

In October 1986, Lockwood Water and Sewer District personnel discovered the presence of benzene and chlorinated solvents in their water supply wells. That discovery led to the initiation of a number of investigations by DEQ of underground storage tanks and a petroleum pipeline in the vicinity of the Lockwood Water and Sewer District property. In June 1998, DEQ Site Response Section performed an Integrated Assessment of the LSGPS.

During the summer of 2000, EPA's Emergency Removal Program extended the public water supply line to the Lomond Lane area and 14 residences with contaminated wells were connected by August 2000. EPA also conducted indoor air sampling, provided mitigation for indoor air contamination, and continued groundwater monitoring. DEQ continued indoor air sampling on a quarterly basis through February 2002.

DEQ began the Remedial Investigation in 2002. The Remedial Investigation included surface and subsurface soil sampling, monitoring well construction and groundwater sampling, aquifer testing, surface water and sediment sampling, and indoor air sampling. Groundwater sampling for protection of human health and contaminant characteristics continues today. DEQ released the Remedial Investigation Report (Tetra Tech EM Inc. [TtEMI] 2003a) in June 2003 and completed the Feasibility Study (TtEMI 2004) in July 2004. In October 2004, EPA's Superfund Technical Support Program evaluated the groundwater and indoor air sampling results collected since the completion of the Remedial Investigation and Feasibility Study Reports (EPA 2004).

2.4 Community Participation

Beginning in June 1998, DEQ asked residents to allow samples of water to be taken from private, residential, commercial, and industrial wells. On September 18, 1998, DEQ issued a news release advising residents of Lomond Lane and Doon Avenue their well water contained high levels of chlorinated solvents, including one solvent known to cause cancer and several probable human carcinogens, and advised the residents not to drink the water. DEQ and EPA held a public meeting on May 12, 1999, at the Lockwood School to report on recent investigations into groundwater contamination. In December 1999, EPA discussed its removal program activities at a public meeting in Lockwood.

DEQ personnel interviewed home and business owners in Lockwood from January 16 to 18, 2001, and then prepared a Community Involvement Plan in October 2001. The Community Involvement Plan identifies issues of concern to the local community regarding the LSGPS. Staff members from the Agency for Toxic Substances and Disease Registry (ATSDR) conducted interviews and an availability session in Lockwood on January 18, 2001, to provide a foundation for a Public Health Assessment and to guide ATSDR in planning their future activities at the LSGPS.

DEQ held two public meetings announcing the release of the Remedial Investigation Report (TtEMI 2003a) in June 2003. The public meetings provided citizens a summary of the findings of the Remedial Investigation, the conclusions of the Risk Assessment, and an opportunity for their questions to be answered. The Feasibility Study (TtEMI 2004) was released in August 2004. Both documents can be found in the Administrative Record file and the information repository maintained at the MSU-Billings Library. DEQ mailed postcards to all interested parties announcing the availability of these two documents and provided newspaper ads in the Billings Gazette and Billings Outpost announcing the public meetings.

DEQ and EPA released the Proposed Plan (DEQ 2004) for public comment on November 15, 2004. DEQ and EPA accepted written comments through January 14, 2005. DEQ provided a direct mailing to interested parties that included either a copy of the Proposed Plan or a postcard announcing the public comment period and encouraging individuals to visit the Administrative Record for a copy of the Proposed Plan. DEQ also provided a press release, newspaper ads, and television interviews. DEQ and EPA held a public meeting and hearing on Thursday, December 2, 2004, at the Lockwood School. DEQ presented the Preferred Alternative and moderated the public hearing during which the public verbally submitted comments, recorded by a court reporter, on the Proposed Plan. Approximately 20 people attended. All comments submitted to DEQ before January 14, 2005, are addressed in Part 3, Responsiveness Summary, of this Record of Decision.

SECTION 3

SUMMARY OF SITE CHARACTERISTICS

3.1 Conceptual Site Model

The Conceptual Site Model (Figure 3) is the framework for understanding the receptors and exposure pathways included in the risk assessments and the fate and transport of the contaminants. The Conceptual Site Model identifies the primary sources located on the Beall and Brenntag properties as the septic system drain field, drums and tanks, and disposal ponds/lagoons. The contaminants are consequently present in surface and subsurface soil. Contaminants migrate from the soil to the groundwater and flow with the groundwater to form contaminant plumes. Contaminants may also volatilize from the soil and shallow groundwater, forming vapors, which then permeate structures (residences). These primary sources and migration pathways result in potential exposures for humans through drinking or using contaminated groundwater or surface water, breathing the air inside residences, or coming into direct contact with contaminated soil.

3.2 Topography and Hydrogeology

Because of the considerable size of the LSGPS, over 580 acres, DEQ divided it into nine subareas for the risk evaluations and site descriptions (Figure 4). The nine areas are Area A (Brenntag source and nonsource areas), Area B (Beall source and nonsource areas), Area C, the AJ Gravel Pond, the Coulson Irrigation Ditch, the wetland area on Cerise Road, and the Yellowstone River.

The Beall and Brenntag Source Areas are located in different portions of the LSGPS and have slightly different geologic and hydrogeologic characteristics.

Groundwater immediately upgradient of the Beall Source Area enters the alluvial aquifer at the contact with the bedrock aquifer (alluvial aquifer boundary) and flows downgradient (northwest) toward the Yellowstone River.

The Beall Source Area is located on an upper terrace of the Yellowstone River floodplain. Alluvial (subsurface) deposits at the Beall Source Area consist primarily of fine-graded sands and silts underlain by a thinner sequence of sand and gravels. These deposits overlie the Eagle sandstone bedrock. Bedrock is exposed southwest of the Beall Source Area at the interchange of Interstate Highway 90 and U.S. Highway 87 East.

Vadose (unsaturated) zone thickness is about 47 feet immediately upgradient of the Beall property, 46 to 49 feet west of the steam clean bay, 43 feet at the west edge of the Beall property, and decreases to 35 feet northwest of the Beall property. Moderate- to low-permeability silts and silty clay were identified in the vadose zone throughout the Beall Source Area and layers of discontinuous sands were observed in some borings. The saturated zone extends from the sands and gravels at the base of the alluvium into the base of the overlying finer grained sediments. The average saturated thickness in the Beall Source Area is about 20 feet. An alluvial aquifer water-level map prepared from July 2003 data indicates a general north and west flow of groundwater from the Beall Source Area toward the Yellowstone River. The groundwater flow gradient at the Beall Source Area is approximately one foot of vertical drop for every 1000 feet of horizontal travel.

Alluvial deposits at the Brenntag Source Area consist primarily of a sequence of mixed silt, clay, and silty sands underlain by deposits of sand and gravel. These alluvial deposits overlay gray sandstone bedrock (Eagle sandstone).

Vadose zone thickness is about 15 feet at the upper (southeastern) portion of the Brenntag property, 10 feet at the main tank farm, and decreases to seven feet northwest of the property. Moderate- to low-permeability silty clays and silty sand units were identified in the vadose zone throughout the area and

thin discontinuous gravels were observed in some borings. The saturated zone extends from the sands and gravels at the base of the alluvium into the overlying finer grained sediments. The average saturated thickness in the Brenntag Source Area is about 20 feet. An alluvial aquifer water-level map prepared from July 2003 data indicates a general northwest flow of groundwater at the Brenntag Source Area. The groundwater flow gradient is approximately seven feet of vertical drop per 1000 feet of horizontal travel.

Six surface water features are located downstream or downgradient of the Beall or Brenntag Source Areas: the Coulson Irrigation Ditch, the AJ Gravel Pond, the Corcoran Pond, the Lower Lockwood Irrigation Ditch, a wetland area, and the Yellowstone River.

The Coulson Irrigation Ditch originates at a diversion structure on the Yellowstone River south (upriver) from the Lockwood Water and Sewer District treatment plant. It flows by gravity to the northeast through the Auto Auction property and then passes along the north boundary of the Brenntag property. The ditch exits the LSGPS beneath Klenck Road and continues through open fields east of the LSGPS. Groundwater influx or seepage into the Coulson Irrigation Ditch occurs during periods when there is no flow in the ditch, where the bottom of the ditch intercepts the water table. Comparisons of water elevation data in the Coulson Irrigation Ditch to water elevations in monitoring wells adjacent to the ditch indicate portions of the Coulson Irrigation Ditch are below the groundwater table.

The AJ Gravel Pond and the Corcoran Pond are located south of the Yellowstone River at the north end of the LSGPS. The ponds are about 1,500 and 1,800 feet downgradient of the Brenntag Source Area and are the result of former sand and gravel mining activities. The water elevations in the ponds are a reflection of water table elevations.

The Lower Lockwood Irrigation Ditch does not interact with the groundwater at the LSGPS and does not affect the site.

A permanent wetland area with small open ponds is located in the west portion of the LSGPS about 4,300 feet downgradient of the Beall property. The wetlands extend from east of Cerise Road northeast toward the Sandy-Lomond Lane area. The wetlands were formed in a former chute channel originating from the Yellowstone River and likely receive groundwater year-round.

The Yellowstone River is the main surface water feature in the LSGPS, and the centerline of the channel marks the western and northern boundaries of the LSGPS. The river is approximately 4,600 feet downgradient of the Beall Source Area and 2,000 feet downgradient of the Brenntag Source Area. The Yellowstone River is expected to intercept the groundwater discharging from the LSGPS.

Current land use within the LSGPS is characterized as residential, commercial, and "light" industrial. Examples of commercial and light industrial businesses in the area include trucking, vehicle repair, truck tank manufacturing, chemical repackaging, machine shops, and auto salvage. At this time, the primary source of domestic use water in the LSGPS is from the public water supply, which obtains its water from the Yellowstone River. However, limited full-use domestic, other domestic (such as irrigation), commercial, and nondomestic use water is known to come from the shallow alluvial aquifer via individual wells.

There are no archeological or historical areas of interest within the boundaries of the LSGPS.

3.3 Characteristics of Contaminants of Concern

There are four contaminants of concern for the LSGPS: tetrachloroethene (PCE), trichloroethene (TCE), dichloroethene (DCE), and vinyl chloride (VC).

3.3.1 Tetrachloroethene

PCE is used as a dry cleaning and textile-processing solvent, for vapor degreasing, and metal cleaning operations. It is also used in the production of chlorofluorocarbons, in aerosol formulations, as a carrier for rubber coatings, solvent soaps, printing inks, adhesives, sealants, polishes, lubricants, and silicones, and as a solvent in various consumer products such as typewriter correction fluid and shoe polishes (EPA 1994). In textile processing, it is used as a scouring solvent that removes oils from fabrics after knitting and weaving operations, and as a carrier solvent for sizing and desizing and for fabric finishes and water repellents. PCE can be used to clean and dry contaminated metal parts and other fabricated materials. It is also present in many paint thinners, brake cleaners, and antifreeze.

At the LSGPS, PCE has been detected in monitoring wells at concentrations greater than 100,000 µg/L in Area A. Low-level concentrations (less than or equal to 10 µg/L) of PCE have been detected in Area B and Area C. The higher concentrations of PCE in groundwater in Area A suggest a historic release occurred during previous storage and handling of products. Records indicate PCE has been stored and handled at the Brenntag facility. In Area B, PCE may have been a minor component (impurity) of the solvents used in a vapor degreasing operation at the Beall facility.

PCE is a colorless, nonflammable liquid that evaporates readily, dissolves only slightly in water, and has a sharp, sweet odor. PCE can be released to the environment via soil, water, and air. In air, PCE breaks down to other compounds over several weeks (ATSDR 1997a). Because PCE is a liquid that does not bind well to soil, PCE released to soil can move through the soil and enter groundwater (EPA 1994). If released to the soil, volatilization will slowly occur with rapid leaching into the soil and groundwater. Under methanogenic conditions, PCE will breakdown into TCE and ultimately end up as VC. PCE can remain in the soil for a long period of time. Under anaerobic conditions in groundwater, PCE undergoes reductive dehalogenation to TCE. In surface water, PCE undergoes volatilization rapidly and will break down into the same compounds (TCE and VC) as in the atmosphere (ATSDR 1997a).

PCE enters the body when breathed in with air or when consumed with contaminated food or water. It is less likely to be absorbed through skin contact. Breathing PCE for short periods of time can adversely affect the central nervous system. Effects range from dizziness, fatigue, headaches, and sweatiness to loss of coordination and unconsciousness. Contact with PCE liquid or vapor irritates the skin, the eyes, the nose, and the throat. These effects are not likely to occur at concentrations of PCE that are normally found in the environment (EPA 1994).

Breathing PCE over longer periods of time can cause liver and kidney damage in humans. Repeated exposure to large amounts of PCE in air can cause memory loss and confusion. Laboratory studies show that PCE causes kidney and liver damage and cancer in animals exposed repeatedly by inhalation and by mouth. Repeated exposure to large amounts of PCE in air may likewise cause cancer in humans (EPA 1994). It is generally agreed by the International Agency for Research on Cancer and EPA that PCE may cause cancer.

3.3.2 Trichloroethene

TCE is used primarily as a solvent to remove grease from metal parts but is also an ingredient in many consumer products (ATSDR 1997b). It is used to break down fats, waxes, resins, oils, rubber, paints, and varnishes (Merck Index 1996) and is also an excellent extraction solvent for greases and tars. TCE is used in the textile processing industry to scour cotton, wool, and other fabrics. The textile industry also uses TCE as a solvent in waterless dyeing and finishing operations. As a general solvent or as a component of solvent blends, TCE is used with adhesives, lubricants, paints, varnishes, paint strippers, pesticides, and cold metal cleaners. TCE is also used in the production of polyvinyl chloride (PVC). Various consumer products found to contain TCE include typewriter correction fluids, paint removers and strippers, adhesives, spot removers, and rug-cleaning fluids. Prior to 1977, TCE was used in veterinary medicine as a general and obstetrical anesthetic, a grain fumigant, surgical disinfectant, a pet food additive, an extractant of spice oleoresins in food, and for production of decaffeinated coffee (ATSDR 1997b). TCE also results as a degradation product of PCE.

At the LSGPS, TCE in Area A may be present as a result of PCE degradation, and may have been released during the storage and handling of product. Records indicate that TCE has been stored and handled at the Brenntag facility. In Area B, concentrations of TCE have been detected in groundwater monitoring wells at concentrations greater than 1,000 µg/L suggesting this compound may have been used in a degreasing operation, or released during the storage or handling of the product. Records indicate that TCE was stored and used in a degreasing operation at the Beall facility.

TCE is a colorless, nonflammable liquid that evaporates quickly, dissolves only slightly in water, has a somewhat sweet odor, and a sweet, burning taste. TCE can be released to the environment via soil, water, and air. TCE binds to soil particles and can remain in soil for a long time (ATSDR 1997b). If released to the soil, volatilization will rapidly occur with some leaching. Under anaerobic conditions, TCE undergoes reductive dechlorination and will break down into cis- and trans-1,2-DCE. In surface water, TCE undergoes volatilization rapidly. TCE may bind to particles in water and settle to bottom sediment (ATSDR 1997b).

TCE can enter the body through inhalation of contaminated dust and vapors or through ingestion of contaminated soil and water. It can also enter the body through the skin. Short-term inhalation exposure to TCE can cause dizziness, headaches, lung irritation, poor coordination, sleepiness, facial numbness, and difficulty concentrating. Inhalation of large amounts of TCE may cause impaired heart function, unconsciousness, and, possibly death. Ingestion of small amounts of TCE for long periods may cause liver and kidney damage, impaired immune system function, and impaired fetal development in pregnant women. Ingestion of large amounts of TCE can adversely affect the central nervous system, and may cause nausea, liver damage, impaired heart function, unconsciousness, and death. Skin contact with TCE for short periods may cause skin rashes (ATSDR 1997b). Some studies with mice and rats have suggested that high levels of TCE may cause liver or lung cancer. Recent studies by EPA have noted that the International Agency for Research on Cancer and the National Toxicology Program find TCE to be “reasonably anticipated to be a human carcinogen.”

3.3.3 Dichloroethene

DCE is used to produce solvents and in chemical mixtures. It is a chemical intermediate in the synthesis of chlorinated solvents and compounds such as VC, and used in mixtures of paints, furniture stripper, metal degreaser, soaps, and as a gasoline additive. It was also an ingredient in WD-40, a common penetrating oil. It has also been used as a low-temperature extraction solvent for organic materials such as decaffeinated coffee, dyes, perfumes, lacquers, and thermoplastics (ATSDR 1996). It is a solvent to break down fats, phenol, and camphor (Merck Index 1996). There is evidence that other chlorinated hydrocarbons introduced into subsurface media can undergo biodegradation to cis-1,2-DCE or trans-1,2-DCE. The parent pollutants include such widely used solvents as TCE or PCE (ATSDR 1996).

At the LSGPS, cis-1,2-DCE may be present as a result of PCE and TCE degradation, and may have been released during storage and handling of product.

DCE is a colorless, highly flammable liquid that evaporates rapidly, dissolves readily in water, and has a sharp, harsh odor. There are two forms of DCE, cis-1,2-DCE and trans-1,2-DCE, the difference being the relative location of chlorine atoms on the molecule. The 1,2-DCE isomer that has the two chlorine groups next to each other is referred to as the cis-isomer; the isomer with the two chlorine groups opposite each other is called the trans-isomer. Sometimes, both forms are reported together as 1,2-DCE and sometimes the individual isomers (cis- and trans-) are reported separately (ATSDR 1996). If released in the soil, some DCE will rapidly volatilize. A small amount will leach into the soil and subsequently to the groundwater. In the groundwater under anaerobic conditions cis-1,2-DCE and trans-1,2-DCE will degrade to VC. In surface water, DCE undergoes volatilization rapidly (ATSDR 1996).

Exposure to DCE can result from breathing contaminated air or by ingesting contaminated food or water. Exposure can also result from skin contact with the chemical. Inhalation of high levels of DCE can cause nausea, drowsiness, and sleepiness. Inhalation of very high levels can cause death. Long-term human health effects after exposure to low concentrations of DCE are not known. Lower doses of DCE caused

effects on the blood such as decreased numbers of red blood cells, and also effects on the liver. EPA has not classified cis-1,2-DCE and trans-1,2-DCE for human carcinogenicity.

3.3.4 Vinyl Chloride

VC is a manufactured substance that is used to make PVC. PVC is used to make a variety of plastic products including pipes, wire and cable coatings, and furniture upholstery. VC also results from the breakdown of other substances, such as PCE, TCE, and cis-1,2-DCE. The presence of VC at the LSGPS is most likely related to degradation of PCE, TCE, or cis-1,2-DCE.

VC is typically a colorless, flammable gas that evaporates easily, dissolves sparingly in water, and has a mild, sweet odor. Vinyl chloride can be in liquid form under high pressure and low temperatures. Liquid VC evaporates easily into the air. If it is near the surface of soil or water, it can also evaporate. VC breaks down in air within a few days. The main degradation products are glycolic acid or carbon dioxide after aerobic conversion and ethane, ethene, methane, or chloromethane after anaerobic transformation (IPCS 2005). VC formed from the breakdown of other chemicals can enter groundwater (ATSDR 1997c). If released to the soil, it will undergo rapid volatilization and may easily leach into the soil because of its solubility in water and most organic solvents. In the groundwater, VC breaks down into ethane under aerobic conditions. In surface water, VC volatilizes and undergoes photodegradation, to form chloroacetaldehyde, formaldehyde, and formyl chloride (IPCS 2005).

VC can enter the body through inhalation of contaminated air, ingestion of contaminated food and water, or absorption through skin and eye contact. Inhalation of high levels of VC can cause dizziness and sleepiness. Breathing very high levels can cause unconsciousness and death. Long-term inhalation exposure can cause changes in liver structure. The effects of ingestion of high levels of VC are unknown. Skin contact with the chemical will cause numbness, redness, and blisters. Long-term dermal exposure may cause nerve damage and immune reactions. Results from several studies have suggested that inhalation or ingestion of drinking water containing low levels of VC may increase the risk of getting cancer. Workers having chronic inhalation exposure have shown increased risk of getting cancer in the liver. Chronic inhalation exposure may cause brain cancer, lung cancer, and some cancers of the blood. EPA has determined that VC is a known human carcinogen.

3.4 Nature and Extent of Contamination

3.4.1 Groundwater

3.4.1.1 Groundwater Sampling Methods and Results

Table 3 identifies the range of contaminant concentrations detected in groundwater and the remediation goal for each contaminant of concern throughout the three main subareas: A, B, and C. Either disposable bailers or low-flow systems were used to collect the groundwater samples. Figure 5 illustrates the extent of the contaminated groundwater at and downgradient of LSGPS source areas that is being considered for remediation. These groundwater areas (784,592 square feet at and downgradient of the Beall Source Area and 1,457,078 square feet at and downgradient of the Brenntag Source Area) are based on groundwater sampling results. These areas include contiguous groundwater monitoring wells in which the MCL for any individual contaminant of concern was exceeded in April 2003. The average thickness of the contaminated aquifer is estimated at 25 feet in the Beall Source Area and 22 feet in the Brenntag Source Area, and the estimated depth of contamination is based on the lower boundary of the alluvial aquifer. Assuming an aquifer effective porosity of 27 percent, the volume of contaminated groundwater at LSGPS that exceeds MCLs is estimated at 13,951,039 cubic feet (104 million gallons) of which 5,295,996 cubic feet (40 million gallons) are located at and downgradient of the Beall Source Area and 8,655,043 cubic feet (64 million gallons) are located at and downgradient of the Brenntag Source Area. In addition, an estimated 667,510 square feet of other site-wide areas had groundwater with individual contaminants of concern above MCLs in April 2003 [see Appendix A and Table 2-3 of the Feasibility Study]

(TtEMI 2004)]. This additional volume of contaminated groundwater is estimated at 4,235,350 cubic feet (32 million gallons).

3.4.1.2 Groundwater Remediation Goals

A remediation goal of 5 µg/L for PCE and TCE, 70 µg/L for cis-1,2-DCE, and 2 µg/L for VC in groundwater will meet the MCL for these contaminants under the Safe Drinking Water Act. Groundwater remediation goals are summarized in Table 1.

3.4.1.3 Non-Aqueous Phase Liquids

During the Remedial Investigation in June 2002, DEQ installed Flute, Inc. Ribbon Samplers at the Brenntag facility to evaluate the presence of liquid chemical products, known as non-aqueous phase liquids (NAPL), that may have been released to the groundwater during facility operation. The ribbon samplers were placed in six hydraulic direct-push borings extending from the surface through the vadose and saturated zones to bedrock (29.1 to 32.8 feet below ground surface). The sampling locations were selected based on suspected sources of contamination and included areas of suspected spills of pure-phase solvents, areas downgradient of the tank farm, and at areas where previous sampling data showed elevated levels of chlorinated solvents in groundwater. NAPL was not detected in the saturated or vadose zones of subsurface soil down to bedrock. However, the high concentrations of chlorinated solvents detected in groundwater samples collected on and near the Brenntag facility strongly suggest the presence of NAPL in the subsurface.

3.4.1.4 Contaminant Fate and Transport in Groundwater

The fate and transport of contaminants released at the Beall and Brenntag Source Areas were evaluated through (1) the analysis of plume behavior through a geochemical characterization, (2) hydrogeological data analysis, (3) statistical analysis of historical analytical data from the samples of the pre-Remedial Investigation monitoring and residential wells, and (4) modeling of the transport and biodegradation of the contaminants of concern. These evaluation characteristics are summarized in the following text. A more detailed discussion of the fate and transport characteristics of the contaminants of concern in groundwater and soil is provided in the Remedial Investigation Report (TtEMI 2003a).

Geochemical Characterization

The Beall Source Area is characterized by a release from the drainfield of wastewater that contained TCE used in tank trailer cleaning operations. Wastewater with higher concentrations of TCE and possibly petroleum components may have been released from a leaking oil-water separator or from subsurface piping exiting the wash bay. No evidence of NAPL release was detected in soil samples or indicated by maximum concentration of contaminants in groundwater samples. The Beall plume extends from the source area downgradient, approximately 4,600 feet northwest to the Yellowstone River. TCE concentrations exceeding regulatory limits extend approximately 2,000 feet downgradient to monitoring wells along the Montana Rail Link Railroad corridor. Within the Beall Source Area and downgradient to Lockwood Road, dissolved oxygen concentrations exceed 1.0 milligrams per liter (mg/L) indicating that reductive dechlorination may not be active in this portion of the plume. Although degradation daughter product cis-1,2-DCE is present in the plume, there is only limited geochemical evidence of ongoing degradation. Degradation of TCE to cis-1,2-DCE in the past is presumed to have consumed the majority of available organic substrate such as matter potentially associated with an on-site septic tank or organics released from the steam clean bay.

The Brenntag Source Area is characterized by releases of what are believed to be PCE and possibly TCE NAPLs, as well as petroleum products and other unidentified organic compounds. While ribbon samplers did not detect NAPL in the vadose or saturated zone soil, the high concentrations of chlorinated solvents in groundwater samples suggest that NAPL-contaminated soil may extend below the water table in the Brenntag Source Area. The chlorinated solvent plume in the alluvial aquifer extends from the Brenntag Source Area to the Yellowstone River. The core of the plume is relatively narrow and is generally less than 300 feet wide. The plume exhibits some lateral dispersion and is approximately 1,300 feet wide where it enters the river approximately 2,000 feet from the source area. A portion of the plume discharges into the AJ Gravel Pond, and an unknown mass of chlorinated solvents likely volatilizes from

and/or degrades in the pond. The bedrock aquifer downgradient from the Brenntag Source Area does not appear to be impacted by chlorinated solvents. Strong lines of geochemical evidence indicate that reductive dechlorination is actively occurring in the Brenntag tank farm area.

Hydrogeological Data Analysis

Hydrogeologic data was evaluated to determine groundwater flow gradients and directions, to assess water-transmitting properties of the aquifer, to estimate the velocity of groundwater flow, and to estimate the transport of contaminants in groundwater. Shallow groundwater flows northwest to the Yellowstone River, according to water-level measurements taken during the Remedial Investigation. The hydraulic conductivity of the alluvial aquifer in the Beall Source Area was estimated to be about 22.4 feet per day from the model calibration. The hydraulic conductivity of the alluvial aquifer in the Brenntag Source Area was estimated to be 70 feet per day from the groundwater model calibration. The site-specific seepage velocity for the plume downgradient of the Beall Source Area was estimated to be about 0.489 feet per day or about 179 feet per year. The site-specific seepage (groundwater) velocity for the plume downgradient of the Brenntag Source Area was estimated to be about 1.7 feet per day or about 625 feet per year. Hydraulic conductivity and seepage values were recalculated in Appendix E of the Feasibility Study (TtEMI 2004) based on additional groundwater monitoring data available since the Remedial Investigation.

Statistical Analysis of Groundwater Concentration Trends

The Beall Source Area exhibited no decreasing trend in the concentrations of TCE or cis-1,2-DCE over time. Concentrations of TCE and cis-1,2-DCE appear to be stable. Long-term monitoring well data were not available further downgradient; therefore, no statistical analyses were conducted at downgradient locations.

Mann-Kendall statistical trend analysis was performed for monitoring well data within the Brenntag Source Area and indicated the concentrations of TCE and cis-1,2-DCE are not decreasing over time at this location. In downgradient monitoring wells, decreasing concentration trends of PCE and TCE coupled with increasing concentrations of daughter products, cis-1,2-DCE and VC, were observed. These observations suggest biodegradation is active in the portion of the plume downgradient of the Brenntag Source Area. One downgradient monitoring well showed decreasing trends in concentrations over time for both parent compounds and daughter products.

Transport and Biodegradation Modeling

Model results support a conclusion that the portion of the plume downgradient of the Beall Source Area is slowly increasing in size.

For the portion of the plume downgradient of the Brenntag Source Area, model results (assuming constant source activity since property development in 1972) suggest that the downgradient edge of the chlorinated solvent plume may have reached the Yellowstone River as early as model year 5 (calendar year 1977). This portion of the plume appears to have reached a maximum length and width by model year 10 (calendar year 1982), and model results suggest no significant changes in the dimensions of the plume have taken place after that time.

3.4.1.5 Exposure Potential to Contaminated Groundwater

The Baseline Human Health Risk Assessment (TtEMI 2003a) concluded the groundwater pathway poses significant risks to human health through ingestion, bathing, and routine industrial activities. Currently, all residences with wells that are impacted with contaminant concentrations above the MCL have been provided the public water supply. DEQ samples seven additional residential wells semi-annually to confirm the contaminant concentrations remain below the MCL. There are no administrative or institutional controls prohibiting the use of groundwater for domestic purposes. Many of the commercial facilities utilize contaminated groundwater for toilet and hand washing facilities as well as vehicle washing and other industrial uses. Left uncontrolled, contaminated groundwater will continue to migrate from the source areas. The area downgradient of Beall, currently with groundwater contaminant concentrations below MCLs, would be adversely impacted above MCLs as groundwater continued to migrate. This area includes residential and commercial wells.

3.4.1.6 Current and Potential Future Groundwater Uses

Currently, groundwater is used for domestic and commercial purposes throughout portions of the site. Given the presence of contamination from various sources in the groundwater, the Lockwood Water and Sewer District is unable to utilize the groundwater for potable water distribution or even maintenance of the distribution system. Currently, public water is obtained from the Yellowstone River; however, without the use of the groundwater wells, there is not a backup water supply. The Administrative Rules of Montana classify the groundwater within the LSGPS as Class I or Class II waters in which contaminants may not exceed the human health standards identified in the Department of Environmental Quality Water Quality Bureau Circular 7. Future use of groundwater within the LSGPS is anticipated to continue as a drinking water supply.

3.4.2 Soil

3.4.2.1 Soil Sampling Methods and Results

Table 4 identifies the range of contaminant concentrations detected in surface and subsurface soil for each contaminant of concern throughout the three main subareas: A, B, and C. Figure 6 and Figure 7 illustrate the extent of known and suspected contaminated soil at the Beall and Brenntag Source Areas considered for remediation. Lateral and vertical extent of known contaminated soil areas are based on soil sampling results where remediation goals are exceeded. DEQ, EPA, Beall, and Brenntag personnel have collected soil samples during numerous investigations beginning in 1998. Soil samples were collected using direct-push methods, auger drilling methods with split-spoons, shovel, or post-hole equipment, and during groundwater well installations. Suspected areas of soil contamination above the remediation goals total 9,862 square feet in the Beall Source Area and 7,454 square feet in the Brenntag Source Area. These areas are inferred from existing soil and groundwater data and the locations of physical features suspected as release points. Soil contamination extends from ground surface to the bottom of the fine grain silty sand formation: an average depth of 45 feet in the Beall Source Area and 14 feet in the Brenntag Source Area. Based on these assumptions, a total volume of 16,437 cubic yards of contaminated soil is estimated in the Beall Source Area and 3,865 cubic yards is estimated in the Brenntag Source Area. These estimates include soil beneath structures and foundations.

3.4.2.2 Site-Specific Soil Screening Levels

The development of soil screening levels and soil remediation goals has been an iterative process. In the Remedial Investigation Work Plan (TtEMI 2002), DEQ presented three different sets of Preliminary Remediation Goals for contaminants in soil. These were (1) EPA Region 9 Residential Preliminary Remediation Goals, (2) EPA Region 9 Industrial Preliminary Remediation Goals, and (3) site-specific soil screening levels. The Preliminary Remediation Goals provided a range of potential cleanup goals that were used to develop the Remedial Investigation Work Plan and Sampling and Analysis Plan (TtEMI 2002). The site-specific soil screening levels were the most conservative (lowest levels) and were developed based on EPA's Soil Screening Guidance: User's Guide (EPA 1996). While the EPA Region 9 Preliminary Remediation Goals are risk-based numbers, the site-specific soil screening levels are based on contaminants leaching to groundwater and establish estimated vadose soil contaminant concentrations that would ensure that groundwater MCLs are not exceeded as precipitation leaches contaminants downward into the groundwater. DEQ did not develop Preliminary Remediation Goals from the Baseline Risk Assessments because the risk assessment established there were no unacceptable human health or ecological risks from contaminated soil.

In the Feasibility Study (TtEMI 2004), DEQ established the Remedial Action Objective for soil to protect groundwater from contaminants leaching from the soil to the groundwater at levels that result in contaminant concentrations in the groundwater exceeding MCLs. DEQ updated and revised the site-specific soil screening levels (Appendix D of the Feasibility Study) for three reasons: (1) some site-specific characteristics and parameters used in calculating the soil screening levels were able to be better defined from Remedial Investigation data; (2) the differences between the Beall and Brenntag Source Areas was considered significant enough to warrant establishing soil screening levels for each area; and (3) it was appropriate to use a modeling approach that was more site-specific than the default approach

used in EPA's Soil Screening Guidance: User's Guide (EPA 1996) because soil screening levels would likely form the basis for cleanup goals. During the public comment period for the Proposed Plan, a commenter identified an error in the infiltration rate used in the soil model. DEQ corrected this error and recalculated soil remediation goals (Appendix C). Table 2 identifies the site-specific remediation goals for these contaminants in soil that will minimize further migration of contaminants from soil to groundwater and protect groundwater cleanup goals.

DEQ and EPA recognize that the modeling performed to derive the site-specific soil remediation goals required assumptions about each of the source areas that may differ somewhat from actual conditions. Consequently, additional information will be obtained during the Remedial Design phase to verify and reflect actual conditions.

3.4.2.3 Contaminant Fate and Transport in Soil

Without active remediation, the contaminants at the LSGPS will remain in soil for long periods of time and have the ability to migrate from soil to groundwater. The contaminants will continue to leach from the soil and contaminate the groundwater to concentrations greater than MCLs.

3.4.2.4 Exposure Potential to Contaminated Soil

The Baseline Risk Assessment concluded direct contact with soil (both surface and subsurface) is considered insignificant and no human health or ecological risks exist. However, as noted above, there remains the continued risk of migration of contamination from the subsurface soil into the groundwater.

3.4.2.5 Current and Potential Future Site and Resource Uses

The Lockwood area is zoned "controlled industrial" (minor industry) according to the Yellowstone City/County Planning Department. The current land use within the LSGPS includes residential, commercial, and "light" industrial operations. There are 81 commercial and light industrial businesses within the boundaries of the LSGPS including trucking companies, a chemical distribution plant, an auto auction facility, auto repair shops, construction companies, a water treatment plant, open agricultural land, a lumberyard, and three active gas stations. An estimated 75 residential single-family residences, two trailer parks, and one apartment complex are currently located within the boundaries of the LSGPS. Current land use of the identified source areas is commercial; specifically tractor trailer manufacture and repair and chemical repackaging and distribution. For the source areas, future land use is reasonably anticipated to continue as commercial. Given the zoning, future development within the LSGPS is anticipated to convert from residential to commercial and industrial uses.

3.4.3 Surface Water and Sediments

3.4.3.1 Surface Water and Sediment Sampling Methods and Results

Table 5 identifies the range of contaminant concentrations detected in surface water and sediment samples for each contaminant of concern in the AJ Gravel Pond, Coulson Irrigation Ditch, and the wetlands on Cerise Road. Groundwater data to date suggests the contaminated groundwater plume does not reach the Corcoran Pond; therefore, it has not been sampled. Collocated surface water and sediment samples were collected first from the most downstream location and last from the farthest upstream sample location so that any sediment disturbances from samples collected upstream did not affect downstream samples. Surface water samples were collected as grab samples by directly immersing sample containers under the water surface. Sediment samples were collected using a disposable scoop and placing the sediment directly in a glass sampling container. Sediment samples were collected from the top 6 inches of the sediment layer.

In 2002, surface water samples from the AJ Gravel Pond contained contaminant concentrations above regulatory criteria. Contamination in the AJ Gravel Pond is attributed to contaminated groundwater discharging into the pond. DEQ estimates there are 13 million gallons of contaminated water in the AJ Gravel Pond based on a surface area of 235,994 square feet and an average depth of 7.4 feet. Contaminants were also detected in surface water from the Coulson Irrigation Ditch and the wetlands

area at concentrations below regulatory criteria and are considered the result of contaminated groundwater discharging to the ditch and wetlands.

In addition, the impact of contaminated groundwater on surface water quality in the Yellowstone River was evaluated. DEQ did not collect samples from the Yellowstone River. A groundwater-surface water mixing model was used to perform an impact analysis of potential changes to surface water quality in the Yellowstone River. A detailed approach for the model is provided in the Remedial Investigation Report (TtEMI 2003a) and is summarized in Part 2, Section 3.4.3.2. The modeling indicated that discharge of contaminated groundwater has negligible impact to the Yellowstone River.

No contaminants of concern were detected above laboratory detection limits in any of the sediment samples.

3.4.3.2 Groundwater-Surface Water Mixing Model

A groundwater-surface water mixing model was constructed to evaluate the potential impact of contaminated groundwater on surface water quality in the Yellowstone River. Model calculations were based on a modified Darcy groundwater flux analysis, as presented in the Remedial Investigation Report (TtEMI 2003). The mixing model was used to estimate the incremental increase in the concentration of contaminants of concern on surface water in the Yellowstone River at low flow using July and August 2002 groundwater quality conditions from seven sentinel monitoring wells. The following set of assumptions was used in the construction of the groundwater-surface water mixing model for the LSGPS (see Remedial Investigation Report, Appendix L-7). These assumptions include:

- Flow statistics were generated using flow data from U.S. Geological Survey (USGS) station number 06214500 located on the Yellowstone River near Billings, Montana. DEQ calculated the lowest mean monthly flow for the 76-year period of record by the USGS (USGS 2003) as 2,491 cubic feet per second. This flow rate was used to calculate the volume of water available for dilution on a daily basis in the Yellowstone River.
- Distance-weighted average groundwater concentrations from wells adjacent to the Yellowstone River in Area A and Area C from the July/August 2002 sampling event were assumed to be representative of the overall groundwater quality available for mixing.
- Less than detection limit values were set equal to the detection limit value for the purpose of all statistical analyses.
- Groundwater flux enters the river along the entire length of the LSGPS adjacent to the Yellowstone River.
- Volatilization of contaminants in surface water was not considered.

The groundwater-surface water mixing model indicated the incremental impact of contaminants in groundwater on surface water quality in the Yellowstone River at low flow would not be detectable with current laboratory detection limits and therefore would be well below any regulatory standard.

3.4.3.3 Contaminant Fate and Transport in Surface Water

Contaminated groundwater continues to discharge to surface water bodies within and downgradient of the LSGPS. The rate of discharge and subsequent impact to surface water quality is dependent on the receiving water. Surface water within the AJ Gravel Pond and wetland areas will return to the groundwater system and eventually be discharged to the Yellowstone River. Coulson Irrigation Ditch likely receives groundwater discharge when no irrigation flow is present. The irrigation flow is moved off-site for irrigation uses down stream.

3.4.3.4 Exposure Potential to Contaminated Surface Water and Sediments

The Baseline Risk Assessment concluded the human exposure routes to surface water and sediments include incidental ingestion and dermal exposures during fishing and wading activities, as well as potential food-chain transfer through recreationally caught fish in the AJ Gravel Pond.

3.4.3.5 Current and Potential Future Site and Resource Uses

Current surface water uses include recreational fishing in the AJ Gravel Pond and off-site irrigation of water in the Coulson Irrigation Ditch. Future surface water usage is not expected to change significantly.

3.4.4 Indoor Air

3.4.4.1 Indoor Air Sampling Methods and Results

Table 6 identifies the range of contaminant concentrations detected in indoor air samples collected by DEQ in residential living spaces for each contaminant of concern. Sampling locations were selected based on the criteria that they were occupied residences overlying groundwater contaminant concentrations in excess of the MCL for any of the contaminants of concern. DEQ collected residential indoor air samples using Method TO-15, Summa canisters, and a 24-hour sample duration. A sample of air is passively drawn through the sampling train, comprised of a flow controller and a particulate filter, which regulate the rate of sampling into the pre-evacuated canister. Originally, DEQ sampled both crawl and living spaces inside homes; however, only living space samples are included in this discussion. DEQ has not calculated approximate volumes of contaminated indoor air.

3.4.4.2 Contaminant Screening

EPA's initial screening of ambient air in residences indicated a concern with vapor contaminant concentrations in living spaces of two residences in January 2000. EPA performed passive vapor mitigation in these residences, and post-mitigation sampling indicated a reduction of PCE vapors to concentrations below EPA's screening levels. Results of DEQ's successive sampling program from April 2001 to February 2002 did not indicate a concern with indoor vapor contaminant concentrations. This conclusion was based on EPA screening levels available in the spring of 2002.

In 2004, EPA's Region 8 Superfund Technical Support Program re-evaluated the indoor air data (EPA 2004). EPA's re-evaluation showed that the PCE and TCE concentrations observed in a number of the residences over the groundwater plume in Area A can be attributed at least in part to vapor intrusion. EPA based this conclusion on evaluation of the relationship between groundwater and indoor air concentrations and comparison to site background levels. Please see Part 2, Section 4.2 for a discussion of the significance of these concentrations.

Background levels of PCE and TCE are present in many homes due to the presence of common consumer products (cleaners, paints, glues), occupant activities (craft hobbies, smoking), and some construction materials (particle board, carpet adhesive). Typical background levels from two different studies, ATSDR, and Lockwood are shown in the following table.

Source	PCE ($\mu\text{g}/\text{m}^3$)	TCE ($\mu\text{g}/\text{m}^3$)
Denver Metropolitan Area	<0.68 to 6.5	<0.26 to 0.7
New York	<0.25 to 3	<0.25 to 0.5
ATSDR	3 to 6	0.7 to 4
Lockwood	<2	<0.2

The background concentrations observed at Lockwood are based on sampling in a residence that is not above the contaminated groundwater plume. The concentrations in this residence fall within the range of background levels observed in the Denver and New York studies.

3.4.4.3 Contaminant Fate and Transport in Indoor Air

For volatile compounds, such as the contaminants of concern at LSGPS, contaminated vapors may migrate from the subsurface and infiltrate enclosed spaces, such as residences. The presence of contaminated groundwater in certain areas of the LSGPS results in indoor air vapor intrusion of levels above site background concentrations.

3.4.4.4 Exposure Potential to Contaminated Indoor Air

In certain areas of the LSGPS, persons living above the contaminated groundwater may be adversely exposed to contaminated indoor air. The significance of these exposures is discussed in Part 2, Section 4.2.

3.5 Source of Contamination

Two primary source areas for chlorinated solvent groundwater contamination have been identified at the LSGPS based on the results of surface water, soil, soil vapor, NAPL ribbon samplers, membrane interface probe, and groundwater sampling from site investigations, including the Remedial Investigation. The two source areas are the Beall Source Area and the Brenntag Source Area. No other source areas have been identified. Vadose and saturated soil with contaminant concentrations above site-specific soil screening levels is considered a potential source for groundwater contamination. No surface or subsurface soil samples from locations outside the Beall and Brenntag Source Areas contained contaminants at concentrations above soil screening levels.

In Area A, concentrations of contaminants above site-specific soil screening levels were reported in vadose soil samples taken from four pilot test well boreholes, eleven soil borings, and six membrane interface probe boreholes. All of these sample locations are either within or downgradient of the Brenntag Source Area and all samples are considered associated with this source area. Table 7 identifies the range of contaminant concentrations detected in the vadose soil samples taken from the Brenntag Source Area for each contaminant of concern. Figure 8 identifies the soil sampling locations in the Brenntag Source Area. Based on analytical data from previous investigations (ATC 2003), the Remedial Investigation (TtEMI 2003a), and from a supplemental membrane interface probe source investigation (TtEMI 2003b), the Brenntag Source Area has been further defined as three NAPL-contaminated areas: the northwest corner, the main tank farm, and the acid tank farm. No other chlorinated solvent sources have been identified in Area A.

In Area B, concentrations of contaminants above site-specific soil screening levels were reported in vadose soil samples taken from one monitoring well borehole, and three soil borings. All of these sample locations are within the Beall Source Area and all are considered associated with this source area. Table 8 identifies the range of contaminant concentrations detected in the vadose soil samples taken from the Beall Source Area for each contaminant of concern. Figure 9 identifies the soil sampling locations in the Beal Source Area. DEQ did not collect soil samples from beneath the oil-water separator and associated steam-clean bay drainage pipe; however, source material is likely to be present below these components based on groundwater concentrations in this area. No other chlorinated solvent sources have been identified in Area B.

In Area C, no concentrations of contaminants of concern above soil screening levels were reported in subsurface or surface soil samples. No chlorinated solvent sources have been identified in Area C.

SECTION 4

BASELINE HUMAN HEALTH AND ECOLOGICAL RISK ASSESSMENT

SUMMARIES

DEQ conducted Baseline Human Health and Ecological Risk Assessments under the Remedial Investigation following EPA guidance. The Baseline Risk Assessments estimate what risks are posed by contaminants at the LSGPS if no action were taken. They provide the basis for taking action and identify the contaminants and exposure pathways that need to be addressed by the Remedial Action. This section summarizes the results of the Baseline Risk Assessments for the LSGPS, including the Indoor Air Re-Evaluation (EPA 2004). Details of the Risk Assessments can be found in the Remedial Investigation Report (TtEMI 2003a).

4.1 Human Health Risk Assessment

4.1.1 Contaminants of Concern

The Baseline Human Health Risk Assessment detailed in the Remedial Investigation Report (TtEMI 2003a) includes a complete list of contaminants of concern for the LSGPS. However, for the Record of Decision and Remedial Action decisions, DEQ has limited the contaminants of concern to four volatile organic compounds: PCE, TCE, cis-1,2-DCE, and VC. While there are other contaminants of concern present at the LSGPS, these four compounds pose the primary risks at the site and direct the remedial actions necessary at the LSGPS.

Tables 9, 10, and 11 present the four main contaminants of concern and exposure point concentrations for groundwater, indoor air, and surface water. While none of the maximum detected concentrations in surface soil exceeded the screening values for direct contact, the soil pathway is still considered complete as a source of contamination to the groundwater because the maximum detected concentrations in subsurface soil exceeded soil screening levels for leaching to groundwater. The tables include the range of concentrations detected for each contaminant of concern, as well as the frequency of detection (the number of times the contaminant was detected in the samples collected at the site), the exposure point concentration, and how the exposure point concentration was derived. The Baseline Human Health Risk Assessment includes a separate table for each subarea and each media; however, for the Record of Decision, the site-wide statistics on the contaminants of concern are included for each media.

4.1.2 Exposure Assessment

The Conceptual Site Model (Figure 3) is useful to identify potential receptors and exposure pathways to be included in the Baseline Human Health and Ecological Risk Assessments. The exposure pathways identified for the LSGPS are further detailed in Table 12. The Risk Assessment process utilizes the exposure point concentrations for each contaminant of concern in each media to calculate a cancer risk for the exposure pathways. Given the size and diverse contaminant concentrations throughout the LSGPS, cancer risks for the exposure pathways were evaluated for each subarea (Figure 4) and each media separately (as identified in Table 12).

Risk Scenarios

The Baseline Human Health Risk Assessment concluded the following scenarios are within EPA's acceptable risk range and considered as insignificant risks:

- Resident adults and children in each of the subareas who use potable water and breathe indoor air.

- Resident adults who use contaminated well water to wash cars or irrigate their lawn in each of the subareas.
- Resident adolescents who recreate with contaminated well water in kiddie pools or sprinklers in each of the subareas.
- Recreators who fish from or wade/dip their arms in the AJ Gravel Pond.
- Utility/construction workers who work in any of the subareas.
- Industrial workers in Area A nonsource, Area B source, Area B nonsource, and Area C subareas who use the public water supply or are supplied an alternate source of drinking water.
- Resident adults and children in Area A nonsource, Area B nonsource, and Area C subareas who use groundwater as a potable water source for whole-house use and/or drinking water source.
- Industrial workers in Area A nonsource, Area B nonsource, and Area C subareas who use groundwater as a potable water source for interior use and/or drinking water source.

The following scenarios and receptors had cancer risks indicating the need for further evaluation or remediation:

- Industrial workers in Area A source and Area B source subareas who use contaminated groundwater for unrestricted workplace use, including drinking and washing.
- Industrial workers in Area A source subarea who spend at least 4 hours of each workday in contact with Area A source subarea groundwater.
- Resident adults and children in Area A source and Area B source subareas who use contaminated groundwater for whole-house use, including bathing, drinking, and washing.

4.1.3 Toxicity Assessment

The toxicity assessment summarized below is based on the Baseline Human Health Risk Assessment (TtEMI 2003a). Please note that a broader range of toxicity factors for indoor air is used in an Indoor Air Re-Evaluation (EPA 2004) discussed in Part 2, Section 4.2.

4.1.3.1 Noncancer Toxicity Values

Table 13 provides non-carcinogenic risk information relevant to the contaminants of concern in groundwater for the oral, dermal, and inhalation pathways.

The potential for noncancer health effects resulting from exposure to contaminants of concern was assessed by comparing an exposure estimate (intake) with a reference dose for oral and dermal exposures, or reference concentration for inhalation exposures. Reference doses and reference concentrations represent average daily intakes (expressed as milligrams per kilogram per day [mg/kg-day] for reference doses and milligrams per cubic meter [mg/m³] for reference concentrations) that are not expected to increase risk of adverse health effects to humans (including sensitive populations) during a chemical-specific exposure period (EPA 1989).

Reference doses and reference concentrations are specific to the contaminant of concern, exposure route, and duration. For this assessment, oral reference doses were used to assess dermal exposures in the absence of route-specific dermal reference doses (EPA 1989).

EPA is in the process of reviewing TCE toxicity values; consequently, the underlying October 1, 2002, toxicity values for TCE are subject to change. At this time, EPA does not have a schedule for completion of its review. Accordingly, pursuant to Region 8 policy, the previous TCE toxicity values (effective prior to 1994) were retained.

For cis-1,2-DCE, a toxicity value has been developed for oral exposure pathways, but not for inhalation. Therefore, a route-to-route extrapolation was performed. This process involves using the toxicity value developed for ingestion and applying it to inhalation. When an oral reference dose was available but no inhalation reference concentration was available, the oral reference dose was adopted as the inhalation reference dose. An inhalation reference concentration was calculated by multiplying the inhalation reference dose by 70 kilograms and then dividing by 20 mg/m³.

4.1.3.2 Cancer Toxicity Values

Table 14 provides carcinogenic risk information relevant to the contaminants of concern in groundwater for the oral, dermal, and inhalation pathways. EPA risk assessment guidance (EPA 1989) defines a slope factor/unit risk factor as a plausible, upper bound estimate of the probability of an individual developing cancer per unit intake of a chemical. Adjustment by a gastrointestinal oral absorption factor was not recommended for the contaminants of concern at LSGPS, as organic chemicals are generally well-absorbed in the gastrointestinal tract (EPA 2001a).

EPA is in the process of reviewing TCE toxicity values; consequently, the underlying October 1, 2002, toxicity values for TCE are subject to change. At this time, EPA does not have a schedule for completion of its review. Accordingly, pursuant to Region 8 policy, the previous TCE toxicity values (effective prior to 1994) were retained.

4.1.4 Summary of Human Health Risk Characterization

The potential for noncarcinogenic effects is evaluated by comparing an exposure level over a chemical-specific time period with a reference dose derived for a similar exposure period. A reference dose represents a level that an individual may be exposed to that is not expected to cause any deleterious effect. The ratio of exposure to toxicity is called a hazard quotient. A hazard quotient (HQ) of less than 1 (HQ<1) indicates that a receptor's dose of a single contaminant is less than the reference dose, and that toxic noncarcinogenic effects from that contaminant are unlikely. The hazard index (HI) is generated by adding the hazard quotients for all contaminants of concern that affect the same target organ (such as liver) or that act through the same mechanism of action within a medium or across all media to which a given individual may reasonably be exposed. A hazard index of less than 1 (HI<1) indicates that, based on the sum of all hazard quotients from different contaminants and exposure routes, toxic noncarcinogenic effects from all contaminants are unlikely. An HI>1 indicates that site-related exposures may present hazards to human health. The hazard quotient is calculated as follows:

$$\text{Non-cancer HQ} = \text{CDI/RfD}$$

where: CDI = Chronic daily intake
RfD = reference dose.

Chronic daily intake and reference dose are expressed in the same units and represent the same exposure period (chronic, subchronic, or short-term).

For carcinogens, risks are generally expressed as the incremental probability of an individual's developing cancer over a lifetime as a result of exposure to the carcinogen. Excess lifetime cancer risk is calculated from the following equation:

$$\text{Risk} = \text{CDI} \times \text{SF}$$

where: risk = a unitless probability of an individual's developing cancer
CDI = chronic daily intake averaged over 70 years (mg/kg-day)
SF = slope factor, expressed as (mg/kg-day)⁻¹.

These risks are probabilities that usually are expressed in scientific notation (such as 1×10^{-6}). An excess lifetime cancer risk of 1×10^{-6} indicates that an individual experiencing the reasonable maximum exposure estimate has a 1 in 1,000,000 chance of developing cancer as a result of site-related exposure. This is referred to as an “excess lifetime cancer risk” because it would be in addition to the risks of cancer individuals face from other causes such as smoking or exposure to too much sun. The chance of an individual’s developing cancer from all other causes has been estimated to be as high as one in three. EPA’s generally acceptable risk range for site-related exposures is 10^{-4} to 10^{-6} .

Tables 15 through 21 identify the carcinogenic risk for each scenario and receptor having cancer risks indicating the need for further evaluation or remediation as presented in Part 2, Section 4.1.2.2.

Industrial workers exposed to contaminated groundwater in Subarea A Source area for four hours per day during routine truck washing or other activities have a 3 in 10,000 chance of developing cancer as a result of site-related exposure (Table 15).

Industrial workers exposed to contaminated groundwater through ingestion, hand washing, and other routine activities, in Subarea A Source area have a 2 in 1,000 chance of developing cancer as a result of site-related exposure (Table 16).

Industrial workers exposed to contaminated groundwater through ingestion, hand washing, and other routine activities, in Subarea B Source area have a 1 in 10,000 chance of developing cancer as a result of site-related exposure (Table 17).

Resident adults utilizing contaminated groundwater for domestic purposes, including ingestion and bathing, in Subarea A Source area have a 5 in 1,000 chance of developing cancer as a result of site-related exposure (Table 18).

Resident children utilizing contaminated groundwater for domestic purposes, including ingestion and bathing, in Subarea A Source area have a 3 in 1,000 chance of developing cancer as a result of site-related exposure (Table 19).

Resident adults utilizing contaminated groundwater for domestic purposes, including ingestion and bathing, in Subarea B Source area have a 2 in 10,000 chance of developing cancer as a result of site-related exposure (Table 20).

Resident children utilizing contaminated groundwater for domestic purposes, including ingestion and bathing, in Subarea B Source area have a 1 in 10,000 chance of developing cancer as a result of site-related exposure (Table 21).

All of the scenarios having excess cancer risks greater than 1 in 10,000 also have a hazard quotient of greater than 1, indicating site-related exposures may present a risk to human health.

The Selected Remedy identified in this Record of Decision is necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances, pollutants, or contaminants into the environment, including continued migration from soil to groundwater.

4.2 Indoor Air Re-Evaluation

EPA’s Region 8 Superfund Technical Support Program re-evaluated the indoor air data (EPA 2004) following the release of EPA’s draft Vapor Intrusion Guidance (EPA 2002) after the completion of the Risk Assessment in the Remedial Investigation Report (TtEMI 2003a). The guidance considers new, more stringent “provisional” toxicity factors for PCE and TCE. A brief synopsis of PCE and TCE toxicity values and corresponding risk-based indoor air concentrations used in the vapor intrusion assessments for the LSGPS is presented below.

PCE Regulatory Risk Levels

The Integrated Risk Information System (IRIS) does not post an inhalation toxicity value. The “old” unit risk factor for PCE that EPA withdrew from IRIS was $5.8 \times 10^{-7} (\mu\text{g}/\text{m}^3)^{-1}$. The corresponding PCE risk based concentrations at the 1×10^{-6} and 1×10^{-4} cancer risk levels are 4.2 and 420 $\mu\text{g}/\text{m}^3$, respectively. EPA’s draft vapor intrusion guidance (EPA 2002) uses a unit risk factor of $3.0 \times 10^{-6} (\mu\text{g}/\text{m}^3)^{-1}$, which was a provisional value provided by EPA’s National Center for Environmental Assessment/Superfund Technical Health Risk Support Center (STSC) for use in the guidance. The corresponding risk based concentrations at the 1×10^{-6} and 1×10^{-4} cancer risk levels are 0.81 and 81 $\mu\text{g}/\text{m}^3$, respectively. As of June 2003, the Office of Emergency and Remedial Response, having consulted with the STSC, is recommending the use of the Cal EPA AIR Toxics Hot Spots Program inhalation unit risk factor of $5.9 \times 10^{-6} (\mu\text{g}/\text{m}^3)^{-1}$. The PCE concentrations corresponding to this unit risk factor at the 1×10^{-6} and 1×10^{-4} cancer risk levels are 0.41 and 41 $\mu\text{g}/\text{m}^3$, respectively.

TCE Regulatory Risk Levels

The EPA has not had definitive guidance or policy regarding TCE toxicity for a number of years. In 1989, EPA withdrew the TCE inhalation toxicity value posted in IRIS. In the absence of a formal inhalation toxicity value, EPA and state environmental agencies continue to use the withdrawn value. This is commonly referred to as the “old withdrawn” value and corresponds to an inhalation unit risk factor of $1.7 \times 10^{-6} (\mu\text{g}/\text{m}^3)^{-1}$. The corresponding TCE risk based concentrations at the 1×10^{-6} and 1×10^{-4} cancer risk levels are 1.4 and 140 $\mu\text{g}/\text{m}^3$, respectively.

In August 2001, EPA’s Office of Research and Development (ORD) completed a reassessment of the existing as well as more recent scientific studies and proposed a range of inhalation toxicity values more stringent than the “old withdrawn” value. These are commonly referred to as the “new provisional” values (EPA 2001b). ORD did not provide guidance on selecting a particular value within the proposed range of toxicity values. The more conservative of the “new provisional” values corresponds to an inhalation unit risk factor of $1.1 \times 10^{-4} (\mu\text{g}/\text{m}^3)^{-1}$. The corresponding TCE risk based concentrations at the 1×10^{-6} and 1×10^{-4} cancer risk levels are 0.022 and 2.2 $\mu\text{g}/\text{m}^3$, respectively. EPA’s draft vapor intrusion guidance (EPA 2002) uses the more conservative of the “new provisional” values. The less conservative of the “new provisional” values corresponds to an inhalation unit risk factor of $5.7 \times 10^{-6} (\mu\text{g}/\text{m}^3)^{-1}$. The corresponding TCE risk based concentrations at the 1×10^{-6} and 1×10^{-4} cancer risk levels are 0.43 and 43 $\mu\text{g}/\text{m}^3$, respectively.

The issue of TCE toxicity continues to undergo review both within EPA and by external groups. At this time, EPA does not have a schedule for completion of its review, but it is anticipated to require several years.

Comparison of Observed Concentrations to Regulatory and Background Levels

The PCE and TCE concentrations observed in the residences considered to be impacted by vapor intrusion are compared to regulatory levels and background levels in order to allow the site’s risk managers to determine the significance of the measured indoor air concentrations at the site.

For PCE, there are eight residences EPA considers impacted by vapor intrusion and in which the indoor concentrations are greater than the site background levels. In four of the residences, the PCE concentrations are also above the background levels observed in recent studies conducted in Denver and New York, as well as the range of background levels considered typical by ATSDR. However, the PCE concentrations in these four residences fall within the acceptable risk ranges for PCE recommended by the Office of Emergency and Remedial Response (that is, the Cal EPA AIR Toxics Hot Spots Program concentrations of 0.41 and 41 $\mu\text{g}/\text{m}^3$).

TCE concentrations are above the site background in seven residences EPA considers impacted by vapor intrusion. The concentrations in five of the residences are also above the background levels observed in recent studies conducted in Denver and New York, but only slightly above or within the range

of background levels considered typical by ATSDR. The upper ranges of TCE concentrations in these residences are above the 1×10^{-4} risk based concentrations using the most conservative of EPA's "new provisional" toxicity values but fall below or within the acceptable risk range using the "old withdrawn" toxicity value or the least conservative of the "new provisional" toxicity values. Based on current toxicology, DEQ and EPA have determined that mitigation measures for indoor air are not necessary at this time. However, monitoring and evaluation of indoor air contaminant concentrations and review of the most recent toxicological information will continue.

As previously noted in Part 2, Section 4.1.4, the Selected Remedy identified in this Record of Decision, which includes groundwater remediation, is necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances, pollutants, or contaminants into the environment.

4.3 Ecological Risk Assessment

The Baseline Ecological Risk Assessment as detailed in the Remedial Investigation Report (TtEMI 2003a) included a detailed screening of all detected contaminants in each medium sampled at the LSGPS specifically for ecological effects. The most conservative available ecological screening values were employed along with updated toxicity information. The LSGPS Baseline Ecological Risk Assessment found all surface water, sediment, and soil concentrations were below conservative screening values. Additionally, a conservative food model was employed to evaluate top-level avian carnivores, such as the bald eagle.

The results of the Baseline Ecological Risk Assessment indicate the LSGPS does not pose an unacceptable risk to ecological receptors. Based on these findings, no action is required to address ecological risk at the LSGPS.

4.4 Uncertainty Analysis

Virtually every step in the Risk Assessment process requires numerous assumptions, all of which contribute to uncertainty in the risk evaluation. DEQ did not collect extensive site-specific exposure data; therefore, assumptions are developed based on best estimates of data quality, exposure parameters, and dose-response relationships. To assist in the development of these estimates, EPA provides guidelines and standard default exposure factors to be used in Risk Assessments (EPA 1989; 1991). The use of these standard factors is intended to promote consistency among risk assessments where assumptions must be made. However, their usefulness in accurately predicting risk depends on their applicability to the site-specific conditions. It is likely, therefore, that the net effect of all the assumptions yields a conservative estimate of total risk. Following are a few examples of uncertainties identified in the Risk Assessment for the LSGPS. Further information and a complete list of uncertainties for the LSGPS can be found in the Risk Assessment sections of the Remedial Investigation Report (TtEMI 2003a).

- For the indoor air data set, contaminants that were detected in underlying groundwater were retained in air for conservative assessment of cumulative risks from all pathways and all media, even if concentrations were below the soil vapor intrusion guidance screening concentrations (EPA 2002). This measure should have overestimated risks by conservatively retaining contaminants of concern.
- Even if contaminants met the criteria for elimination in a dataset based on frequency of detection alone (minimum 20 samples, with frequency less than 5 percent detection), if they were degradation products of either TCE or PCE, they were conservatively retained for cumulative assessment. This measure should have overestimated risks by conservatively retaining contaminants of concern.
- EPA continues the reassessment of TCE toxicity. Because EPA will not complete the reassessment within the next few years, DEQ and EPA developed the Selected Remedy with remediation components to reduce contaminant concentrations in groundwater that would address potential indoor vapor intrusion.

SECTION 5

REMEDIAL ACTION OBJECTIVES

DEQ and EPA have established Remedial Action Objectives for each contaminated medium. Remedial Action Objectives are general descriptions of what DEQ and EPA strive to accomplish in order to protect human health against unacceptable risk. Remedial Action Objectives were not developed for ecological receptors because contaminants at the LSGPS do not pose an unacceptable risk to ecological receptors. Using the Remedial Action Objectives, DEQ and EPA then identify and screen remedial alternatives that will achieve protection of human health and the environment consistent with reasonably anticipated land use and beneficial use of groundwater.

5.1 Groundwater and Surface Water

The following Remedial Action Objectives are defined for groundwater and surface water at the LSGPS:

- Prevent exposure of humans to groundwater and surface water contaminants in concentrations above regulatory standards.
- Reduce contaminant concentrations in the alluvial aquifer and surface water to below regulatory standards.
- Prevent or minimize further migration of the contaminant plume.

5.2 Soil

The following Remedial Action Objective is defined for soil at the LSGPS:

- Prevent or minimize further migration of contaminants from source materials (soil) to groundwater.

SECTION 6

DESCRIPTION OF ALTERNATIVES

The remedy components of each alternative are listed in Table 22. Further discussion of all remedy components are found in the Feasibility Study (TtEMI 2004) and the Selected Remedy components are found in Part 2, Section 9.

6.1 Description of Remedy Components

6.1.1 Alternative 1

The No Further Action alternative (Alternative 1) is required by the NCP. The No Further Action alternative provides a baseline against which other alternatives are compared. Under this alternative, no action is taken to alter current conditions at the LSGPS.

Treatment Technologies

- None

Containment Components

- None

Institutional Controls

- None

Operation and Maintenance

- None

Monitoring

- 5-year reviews

6.1.2 Alternative 2

Alternative 2 is the least aggressive approach to remediation and will protect human health and the environment through institutional controls.

Treatment Technologies

- None

Containment Components

- None

Institutional Controls

- Zoning
- Deed Notices/Deed Restrictions
- Environmental Control Easements
- Controlled Groundwater Area

- Community Awareness/Education
- Risk Mitigation Measures

Operation and Maintenance

- None

Monitoring

- 5-year reviews
- Residential Groundwater wells

6.1.3 Alternative 3

Alternative 3 involves institutional controls, risk mitigation measures, excavation and thermal treatment of contaminated soil, and monitored natural attenuation of groundwater. Although migration of contaminants from soil to groundwater is greatly reduced under this alternative, monitored natural attenuation is not expected to reduce groundwater contaminant levels downgradient of the Beall Source Area and site-wide groundwater. Therefore, groundwater contaminant concentrations in those areas will likely remain above Remedial Action Objectives.

Treatment Technologies

- Excavation and Thermal Treatment of 20,302 cubic yards of soil to below site-specific soil screening levels, identified as source materials constituting principal threat wastes
- Monitored Natural Attenuation of 136 million gallons of groundwater to below regulatory levels
- Treatment of air emissions from Thermal Treatment unit

Containment Components

- None

Institutional Controls

- Zoning
- Deed Notices/Deed Restrictions
- Environmental Control Easements
- Controlled Groundwater Area
- Community Awareness/Education
- Risk Mitigation Measures

Operation and Maintenance

- None

Monitoring

- 5-year reviews
- Residential Groundwater wells
- Site-wide groundwater wells for Monitored Natural Attenuation parameters and contaminant concentrations

6.1.4 Alternative 4

Alternative 4 includes active treatment of groundwater with enhanced bioremediation followed by monitored natural attenuation while relying upon institutional controls and risk mitigation measures for protection of human health and the environment over the long term. Alternative 4 does not provide for source soil remediation. Groundwater contaminant concentrations within source areas are expected to remain above Remedial Action Objectives over the long term or rebound above Remedial Action Objectives due to continued migration of contaminants from the source areas. Continued enhanced bioremediation of groundwater within the source areas will be required over the long term.

Treatment Technologies

- Enhanced Bioremediation and Monitored Natural Attenuation of 136 million gallons of groundwater to below regulatory levels

Containment Components

- None

Institutional Controls

- Zoning
- Deed Notices/Deed Restrictions
- Environmental Control Easements
- Controlled Groundwater Area
- Community Awareness/Education
- Risk Mitigation Measures

Operation and Maintenance

- Continued Enhanced Bioremediation of groundwater until remediation goals are met

Monitoring

- 5-year reviews
- Residential Groundwater wells
- Site-wide groundwater wells for Monitored Natural Attenuation parameters and contaminant concentrations

6.1.5 Alternative 5

The approach to remediation under Alternative 5 includes active in-situ treatment of contaminated groundwater and soil using air sparging and soil vapor extraction followed by monitored natural attenuation. Institutional controls and risk mitigation measures for protection of human health and the environment over the long term are necessary. Groundwater contaminant concentrations in the Brenntag Source Area are expected to remain above or rebound to levels above Remedial Action Objectives and regulatory limits over the long term due to the continued migration of contaminants from untreated saturated zone soil areas.

Treatment Technologies

- Soil Vapor Extraction of 18,369 cubic yards of soil to below site-specific soil screening levels, identified as source materials constituting principal threat wastes
- Air Sparging and Soil Vapor Extraction and Monitored Natural Attenuation of 136 million gallons of groundwater to below regulatory levels

- Treatment of air emissions from Soil Vapor Extraction units

Containment Components

- None

Institutional Controls

- Zoning
- Deed Notices/Deed Restrictions
- Environmental Control Easements
- Controlled Groundwater Area
- Community Awareness/Education
- Risk Mitigation Measures

Operation and Maintenance

- Continued operation of Air Sparging and Soil Vapor Extraction systems until remediation goals are met

Monitoring

- 5-year reviews
- Residential Groundwater wells
- Site-wide groundwater wells for Monitored Natural Attenuation parameters and contaminant concentrations

6.1.6 Alternative 6

The approach to remediation under Alternative 6 includes a combination of groundwater and soil treatments that will achieve Remedial Action Objectives in all media and do not rely upon institutional controls and risk mitigation measures for protection of human health and the environment over the long term.

Treatment Technologies

- Enhanced Bioremediation and Monitored Natural Attenuation of 136 million gallons of groundwater to below regulatory levels
- Soil Vapor Extraction, In-Situ Chemical Oxidation, and Excavation and Thermal Treatment of 20,302 cubic yards of soil to below site-specific soil screening levels, identified as source materials constituting principal threat wastes
- Treatment of air emissions from Soil Vapor Extraction and Thermal Treatment units

Containment (with Treatment) Components

- Permeable Reactive Barrier at Brenntag Source Area across main portion of plume extending to bedrock layer

Institutional Controls

- Zoning
- Deed Notices/Deed Restrictions
- Environmental Control Easements
- Controlled Groundwater Area

- Community Awareness/Education
- Risk Mitigation Measures

Operation and Maintenance

- Continued operation of Soil Vapor Extraction system until remediation goals are met
- Continued In-Situ Chemical Oxidation of soil and groundwater until remediation goals are met
- Continued Enhanced Bioremediation of groundwater until remediation goals are met
- Replacement of Permeable Reactive Barrier after approximately 15 years

Monitoring

- 5-year reviews
- Residential Groundwater wells
- Site-wide groundwater wells for Monitored Natural Attenuation parameters and contaminant concentrations

6.1.7 Alternative 7

The approach to remediation under Alternative 7 includes a combination of in-situ groundwater and soil treatments and hydraulic containment that will achieve Remedial Action Objectives in all media and do not rely upon institutional controls and risk mitigation measures for protection of human health and the environment over the long term.

Treatment Technologies

- Soil Vapor Extraction and In-Situ Chemical Oxidation of 20,302 cubic yards of soil to below site-specific soil screening levels, identified as source materials constituting principal threat wastes
- Monitored Natural Attenuation of 136 million gallons of groundwater to below regulatory levels
- Treatment of air emissions from Soil Vapor Extraction units

Containment (with Treatment) Components

- Permeable Reactive Barrier at both Beall and Brenntag Source Areas across main portions of plumes extending to bedrock layer
- Hydraulic Barrier at the Beall Source Area plume leading edge

Institutional Controls

- Zoning
- Deed Notices/Deed Restrictions
- Environmental Control Easements
- Controlled Groundwater Area
- Community Awareness/Education
- Risk Mitigation Measures

Operation and Maintenance

- Continued operation of Soil Vapor Extraction system until remediation goals are met
- Continued In-Situ Chemical Oxidation of soil and groundwater until remediation goals are met
- Replacement of Permeable Reactive Barriers after approximately 15 years
- Continued operation of Hydraulic Barrier until remediation goals are met

Monitoring

- 5-year reviews
- Residential Groundwater wells
- Site-wide groundwater wells for Monitored Natural Attenuation parameters and contaminant concentrations

6.1.8 Alternative 8

The approach to remediation under Alternative 8 includes an aggressive combination of available groundwater and soil treatment options that will achieve Remedial Action Objectives in all media in the shortest timeframe of all the alternatives and does not rely upon institutional controls and risk mitigation measures for protection of human health and the environment over the long term.

Treatment Technologies

- Excavation and Thermal Treatment and In-Situ Chemical Oxidation of 20,302 cubic yards of soil to below site-specific soil screening levels, identified as source materials constituting principal threat wastes
- Enhanced Bioremediation and Monitored Natural Attenuation of 136 million gallons of groundwater to below regulatory levels
- Treatment of air emissions from Soil Vapor Extraction and Thermal Treatment units

Containment (with Treatment) Components

- Permeable Reactive Barrier at both Beall and Brenntag Source Areas across main portions of plumes extending to bedrock layer
- Air Sparging and Soil Vapor Extraction at the Beall Source Area plume leading edge

Institutional Controls

- Zoning
- Deed Notices/Deed Restrictions
- Environmental Control Easements
- Controlled Groundwater Area
- Community Awareness/Education
- Risk Mitigation Measures

Operation and Maintenance

- Continued operation of Air Sparging and Soil Vapor Extraction system until remediation goals are met
- Continued In-Situ Chemical Oxidation and Enhanced Bioremediation of groundwater until remediation goals are met

- Replacement of Permeable Reactive Barriers after approximately 15 years

Monitoring

- 5-year reviews
- Residential Groundwater wells
- Site-wide groundwater wells for Monitored Natural Attenuation parameters and contaminant concentrations

6.2 Common Elements and Distinguishing Features of Each Alternative

6.2.1 Applicable or Relevant and Appropriate Requirements (ARARs)

Appendix B contains the complete list of ARARs and Table 25 includes a comparison summary for each alternative.

Alternatives 1, 2, 3, 4, and 5 are expected to meet all federal, state, and local ARARs, except contaminant-specific ARARs for groundwater and surface water. Groundwater and surface water contaminant concentrations in portions of the LSGPS are expected to remain above Remedial Action Objectives and remediation goals over the long term for these five alternatives.

Alternatives 6, 7, and 8 are expected to meet all federal, state, and local ARARs, including contaminant-specific ARARs for groundwater and surface water, over the long term. Groundwater contaminant concentrations within and downgradient of source areas are expected to meet Remedial Action Objectives and remediation goals over the long term.

There are no federal or state contaminant-specific soil quality standards.

All treatment residuals produced through remedial actions can and will be handled in accordance with ARARs.

6.2.2 Long-Term Reliability of Remedy

Alternatives 1, 2, 3, 4, and 5 rely on institutional controls for protection from residual risks at the site over the long term. Institutional controls are considered moderately reliable because they rely on human actions. All technology options being considered in the alternatives are considered reliable over the long term but each depends upon proper design, implementation, and maintenance.

6.2.3 Untreated Waste and Treatment Residuals

Alternatives 1 and 2 would leave all of the waste untreated in the environment and would not result in any residual waste. Alternative 3 would generate residual waste of air emissions that may require treatment. Alternative 4 would leave all principal threat waste untreated in the soil with limited concentrations of contaminants remaining in the groundwater and would not generate residual waste. Alternative 5 would leave untreated waste in the saturated soil at the Brenntag Source Area (approximately 1,933 cubic yards) but would treat all waste in the vadose soil. Alternatives 5 through 8 would treat contamination in both soil and groundwater and generate residual waste of air emissions that may require treatment.

6.2.4 Estimated Time for Design and Construction

All components within each alternative can be designed and constructed in one year or less.

6.2.5 Estimated Time to Meet Remedial Action Objectives

Table 23 summarizes the estimated time to meet Remedial Action Objectives for each alternative. Remedial Action Objectives will not be met in the long term for either groundwater or soil under Alternatives 1 and 2. Remedial Action Objectives for soil in the two source areas will be met in one year under Alternatives 3 and 8 and in five years under Alternatives 6 and 7. Beall Source Area soil will meet Remedial Action Objectives in five years under Alternative 5. Alternatives 4 and 5 do not meet Remedial Action Objectives for Brenntag Source Area soil and Alternative 4 does not meet Remedial Action Objectives for Beall Source Area soil.

Remedial Action Objectives will not be met in the long term for either source area groundwater plumes under Alternatives 1 through 5. Remedial Action Objectives will be met in source area groundwater in the long term under Alternatives 6, 7, and 8 because these alternatives include source removal and/or treatment in combination with source area groundwater treatment. Site-wide groundwater will not meet Remedial Action Objectives in the long term under Alternatives 2 and 3 and is expected to meet Remedial Action Objectives in nine years under Alternatives 4, 6, and 8. Groundwater downgradient of Beall is expected to meet Remedial Action Objectives in 24 years and downgradient of Brenntag in 10 years under Alternatives 5 and 7.

6.2.6 Cost

The cost estimate for each alternative is based on estimates of capital, periodic and operation and maintenance costs. Part 2, Section 7.2.5 details the comparison of alternative costs. Table 24 details the estimated costs associated with each alternative. The costs are projected for 30 years using a seven percent (7 percent) discount rate.

6.2.7 Use of Presumptive Remedies and/or Innovative Technologies

A presumptive remedy is a technology that EPA believes, based upon its past experience, generally will be the most appropriate remedy for a specified type of site. EPA establishes presumptive remedies to accelerate site-specific analysis of remedies by focusing the feasibility study efforts. EPA expects that a presumptive remedy, when available, will be used for all CERCLA sites except under unusual circumstances.

Innovative technologies are generally those technologies that are approaching commercial viability and may help remedial and corrective action project managers in dealing with near-term cleanup issues and decisions (EPA 2005). Innovative technologies that were considered for the LSGPS include activated carbon treatment, air stripping, bioremediation, chemical oxidation, soil excavation, monitored natural attenuation, permeable reactive barriers, pump and treat, soil vapor extraction and air sparging, and thermal treatment.

Excavation and thermal treatment is a presumptive remedy for remediation of chlorinated solvents in soil and is a component of Alternatives 3, 6, and 8. Soil vapor extraction is a presumptive remedy for chlorinated solvents in soil and is a component of Alternatives 5, 6, 7, and 8. Alternatives 1, 2, and 4 do not include a presumptive remedy. EPA considers each of the active remediation options evaluated for use at the LSGPS as innovative.

6.2.8 Expected Outcomes

Direct contact with contaminated soil is not considered a risk to human health at this time based on current land use scenarios. However, future land use may be hindered if current source areas are redeveloped for residential use. Ingestion and domestic or commercial use of contaminated groundwater poses a current and future risk to human health. Under Alternatives 6, 7, and 8, source area and site-wide groundwater will be restored to below drinking water standards for the contaminants of concern in the long term. Groundwater use will be regulated through the establishment of a Controlled Groundwater Area until groundwater is remediated to below drinking water standards for the contaminants of concern. At that time, the Controlled Groundwater Area may be modified or revoked.

SECTION 7

SUMMARY OF THE COMPARATIVE ANALYSIS OF ALTERNATIVES

The NCP identifies nine criteria to be used to evaluate the different remediation alternatives individually and against each other in order to select a remedy. The nine evaluation criteria and a summary of the comparative analysis are discussed below. A more detailed evaluation of alternatives for the threshold and balancing criteria may be found in the Feasibility Study (TtEMI 2004). Part 2, Section 7.3 summarizes DEQ's evaluation and analysis of the modifying criteria of support agency and community acceptance. Table 25 captures the comparative analysis for each alternative and each criterion.

7.1 Threshold Criteria

7.1.1 Overall Protection of Human Health and the Environment

Overall Protectiveness of Human Health and the Environment assesses whether each alternative provides adequate protection of human health and the environment. The overall assessment of protection draws on the evaluations of long-term effectiveness and permanence and short-term effectiveness. Protectiveness focuses on how risks associated with the LSGPS are reduced or eliminated by each alternative. Risk reductions are associated with how effectively an alternative meets the Remedial Action Objectives. This criterion is considered a threshold requirement and must be met by the selected alternative.

Because Alternative 1 is not protective of human health and the environment, it is eliminated from consideration under the remaining eight criteria.

Alternatives 2 through 8 provide adequate, but not equal, protection of human health and the environment by eliminating, reducing, or controlling risk through treatment, engineering controls, and/or institutional controls. Contaminants in soil are treated to achieve Remedial Action Objectives in Alternative 3 (excavation and thermal treatment), Alternative 6 (soil vapor extraction, excavation and thermal treatment, and in-situ chemical oxidation), Alternative 7 (soil vapor extraction and in-situ chemical oxidation), and Alternative 8 (excavation and thermal treatment and in-situ chemical oxidation). Contaminants in groundwater are treated to achieve Remedial Action Objectives in Alternative 6 (permeable reactive barrier, enhanced bioremediation, and natural attenuation), Alternative 7 (permeable reactive barrier and natural attenuation), and Alternative 8 (permeable reactive barrier, air sparging/soil vapor extraction, enhanced bioremediation, and natural attenuation). Alternatives 6, 7, and 8 provide greater overall protection than Alternatives 2 through 5.

The results of the Baseline Ecological Risk Assessment for the LSGPS indicated the site did not pose an unacceptable risk to ecological receptors. Based on these findings, no action is required to address ecological risk at the LSGPS.

7.1.2 Compliance with Applicable or Relevant and Appropriate Requirements (ARARs)

Compliance with ARARs evaluates whether the alternative meets federal and state environmental statutes, regulations, and other requirements applicable or relevant and appropriate to the site. This criterion is also a threshold requirement that must be met by the selected alternative unless EPA invokes an ARAR waiver.

All location- and action-specific ARARs are met for Alternatives 2 through 8. Contaminant-specific ARARs for groundwater and surface water may not be met in Alternatives 2 through 5. There are no federal or state contaminant-specific ARARs for soil. All ARARs are met in Alternatives 6 through 8.

7.2 Primary Balancing Criteria

7.2.1 Long-Term Effectiveness and Permanence

Each alternative is evaluated in terms of risk remaining at the LSGPS after Remedial Action Objectives have been met. The primary focus of this evaluation is the extent and effectiveness of controls used to manage the risk posed by treatment of residual or untreated wastes.

Institutional controls are necessary to mitigate long-term residual risk for Alternatives 2 through 4. Institutional controls are considered only moderately reliable. Alternative 2 does not provide for any reduction in risk in any of the contaminated media. Alternative 3 does not provide for a reduction of contaminant levels in surface water or groundwater; however, there will not be residual risk in soil. Alternative 4 does not reduce the residual risk in soil and leaves residual risk in groundwater above levels considered acceptable. Alternative 5 leaves residual risk in source area groundwater and soil above levels considered acceptable. Alternatives 6 through 8 reduce residual risk to achieve Remedial Action Objectives in all environmental media over the long term. Alternatives 6, 7, and 8 provide greater long-term effectiveness and permanence than Alternatives 2 through 5.

7.2.2 Reduction of Toxicity, Mobility, or Volume through Treatment

This evaluation criterion addresses the statutory preference for treatment options that permanently and significantly reduce toxicity, mobility, or volume of the contaminants.

Alternative 2 provides no reduction in toxicity, mobility, or volume of contaminants. Alternative 3 relies on natural attenuation to reduce the toxicity and volume of contaminants in the groundwater outside of the source areas. Alternatives 4 through 8 reduce the toxicity and volume of contaminants through treatment of contaminated groundwater. Under these alternatives, approximately 136 million gallons of contaminated groundwater is treated. These alternatives permanently destroy or remove the contaminants within the groundwater aquifer.

Alternatives 3, 5, 6, 7, and 8 reduce the toxicity and volume of contaminants found in soil. Under Alternatives 3 and 8, contaminants are removed from approximately 20,302 cubic yards of excavated soil by thermal treatment. Under Alternative 6, approximately 3,865 cubic yards of soil are thermally treated. Contaminants are destroyed in-situ with chemical oxidation under Alternatives 6, 7, and 8. Contaminants are removed from vadose soil with soil vapor extraction under Alternatives 5, 6, and 7. Alternatives 6, 7, and 8 remediate contaminated soil at and below the water table at the Brenntag Source Area (approximately 1,933 cubic yards) that Alternative 5 cannot remediate due to the limitations of soil vapor extraction. In addition, the effectiveness of Alternative 5 is diminished due to soil heterogeneity. Excavation and thermal treatment provide a direct and rapid means of contaminant destruction for accessible contaminated soil at the Brenntag Source Area. Soil vapor extraction is not as reliable and has longer remediation time frames than excavation and thermal treatment but is a viable alternative for inaccessible, deep soil at the Beall Source Area and inaccessible soil under existing structures at both source areas.

Alternatives 6, 7, and 8 reduce the mobility of contaminants in the groundwater with permeable reactive barriers. Alternative 7 further reduces contaminant mobility in groundwater downgradient of the Beall Source Area through hydraulic containment, provided by a pump and treat system. Alternative 4 provides no reduction in contaminants mobility in either soil or groundwater. Soil removal and thermal treatment under Alternatives 3, 6, and 8 greatly reduces the mobility of contaminants migrating from vadose and saturated soil to groundwater.

7.2.3 Short-Term Effectiveness

Short-term effectiveness addresses the period of time needed to implement the remedy and any adverse impacts that may be posed to workers, the community, and the environment during construction and operation of the remedy until cleanup levels are achieved. It also includes the estimated time for a remedy to achieve cleanup levels.

Each component of each alternative can be constructed within about one year. DEQ and EPA anticipate the time frame to implement the remedy will be up to 6 years; however, timeframes will depend upon Remedial Design.

Alternatives 2 through 8 have short-term impacts to workers, the public, and the environment during implementation. Alternatives 2 through 8 implement risk mitigation measures and site monitoring that will have minimal impacts to workers, the public, and the environment. Alternatives 4, 5, 6, 7, and 8 have installed aboveground treatment components that may create minor visual and auditory nuisances. The potential for direct contact with contaminants in groundwater occurs when the groundwater remediation systems are operating. Thermal treatment facilities required under Alternatives 3, 6, and 8 function only temporarily. Excavation activities under Alternatives 3, 6, and 8 require disruption and removal of some facilities to be effective. Environmental drilling to install monitoring wells and/or extraction and injection wells occurs under Alternatives 4 through 8. Environmental drilling and excavation may produce contaminated soil cuttings and liquids that present some risk to environmental workers at the LSGPS. Groundwater monitoring has minimal impact on environmental workers responsible for periodic sampling. Treated air discharges to the environment under Alternatives 3, 5, 6, 7, and 8. No off-site water discharges occur under any of the alternatives.

Table 23 summarizes the estimated time to meet Remedial Action Objectives for each alternative. Remedial Action Objectives will not be met in the long term for either groundwater or soil under Alternative 2. Remedial Action Objectives for soil in the two source areas will be met in one year under Alternatives 3 and 8 and in five years under Alternatives 6 and 7. Beall Source Area soil will meet Remedial Action Objectives in five years under Alternative 5. Alternatives 4 and 5 do not meet Remedial Action Objectives for Brenntag Source Area soil and Alternative 4 does not meet Remedial Action Objectives for Beall Source Area soil. Remedial Action Objectives will not be met in the long term for either source area groundwater plumes under Alternatives 2 through 5. Remedial Action Objectives will be met in source area groundwater in the long term under Alternatives 6, 7, and 8. Site-wide groundwater will not meet Remedial Action Objectives in the long term under Alternatives 2 and 3 and is expected to meet Remedial Action Objectives in nine years under Alternatives 4, 6, and 8. Groundwater downgradient of Beall is expected to meet Remedial Action Objectives in 24 years and downgradient of Brenntag in 10 years under Alternatives 5 and 7.

7.2.4 Implementability

This criterion addresses the technical and administrative feasibility of implementing an alternative and the availability of various services and materials required for its implementation.

Alternative 2 is easy to construct and operate as it only involves risk mitigation measures and long-term monitoring.

Soil excavation and soil vapor extraction construction under Alternatives 3, 6, and 8 are moderately difficult in areas where operating facilities exist and may require special techniques or facility relocation. Thermal treatment and soil vapor extraction systems are considered easy to operate, although air discharge limits will need to be met. In-situ chemical oxidation is considered easy to construct and operate under Alternatives 6, 7, and 8.

Permeable reactive barriers are moderately difficult to construct at the Brenntag Source Area due to the depth and uneven bedrock surface under Alternatives 6, 7, and 8 and difficult to construct in the Beall Source Area due to depth under Alternatives 7 and 8. However, permeable reactive barriers have been

successfully installed at other similar sites and expected construction difficulties are not considered insurmountable. Permeable reactive barriers are expected to be easy to operate. Air sparge and soil vapor extraction groundwater treatment components under Alternatives 5, 7, and 8 and in-situ enhanced bioremediation components under Alternatives 4, 6, and 8 are considered easy to construct and operate.

Thermal treatment of excavated soil is considered the most reliable soil treatment option compared to either soil vapor extraction or in-situ chemical oxidation. Soil vapor extraction and in-situ chemical oxidation are both limited by the heterogeneous subsurface environment and presence of low-permeability, fine-grain silt and clay. Permeable reactive barrier treatment, air sparge and soil vapor extraction, and in-situ bioremediation are all considered moderately reliable technologies. Site-specific pilot tests or design studies are considered necessary for each in order to maximize effectiveness.

Services, equipment, and materials are considered available for all alternatives and all alternatives are considered administratively feasible.

Finally, Alternatives 2 through 8 require routine monitoring and sampling including 5-year CERCLA reviews. Alternatives 4 through 8 require periodic operation and maintenance, including system monitoring and sampling, replacing parts and pumps periodically, cleaning components, and replacing the granular activated carbon, which will continue for the life of the treatment.

7.2.5 Cost

The cost estimate for each alternative is based on estimates of capital and operation and maintenance costs. Costs are developed following EPA guidelines for cost estimates during the Feasibility Study (EPA 2000). The types of costs that are assessed include the following:

- Capital costs, including both direct and indirect costs
- Annual operation and maintenance costs, including long-term effectiveness monitoring cost
- Periodic cost, including preparation of the 5-year review
- Net present worth of capital, operation and maintenance costs, and periodic costs

Direct costs include the purchase of equipment, labor, and materials necessary to construct the alternative. Indirect costs include those for engineering, financial, and other services, such as testing and monitoring. Annual operation and maintenance costs for each alternative include maintenance materials, labor, and auxiliary materials, as well as operating costs. Periodic costs include such items as 5-year reviews, risk mitigation measures, recurring injection of chemical oxidation or anaerobic/aerobic treatments, and replacement of permeable reactive barriers.

The present worth of each alternative provides the basis for the cost comparison. The present worth cost represents the amount of money that, if invested in the initial year of the Remedial Action at a given rate, would provide the funds required to make future payments to cover all costs associated with the Remedial Action over its planned life. The cost estimates of the remedial alternatives are based on estimates provided through Remedial Action Cost Engineering and Requirements (RACER 2003) and vendor quotes when available and are current for 2003.

Table 24 details the estimated costs associated with each alternative. The costs are projected for 30 years using a seven percent (7 percent) discount rate. The present worth costs increase from Alternative 1 at \$90,600 to Alternative 8 at \$20,372,500.

7.3 Modifying Criteria

7.3.1 Support Agency Acceptance

This criterion evaluates the technical and administrative issues and concerns the state (or the support agency in the case of State-lead sites) may have regarding the alternative. DEQ is the lead agency for the technical evaluation of the LSGPS. EPA has consulted with DEQ throughout conduct of the Remedial Investigation and Feasibility Study, the development of the Proposed Plan, and in selection of the remedy. EPA concurs with this remedy and approves this Record of Decision without reservations.

7.3.2 Community Acceptance

This criterion identifies community support for, reservations about, or opposition to various components of the alternatives. During the public comment period for the Proposed Plan, several commenters expressed support for Alternative 7 and encouraged aggressive remedial action through widespread excavation and enhanced bioremediation. The public also expressed concern as to the possible formation of dioxins as a byproduct of thermal treatment. The two Responsible Parties proposed modifications to the Preferred Alternative as identified in the Proposed Plan. DEQ and EPA responses to the public comments are detailed in Part 3, Responsiveness Summary of this Record of Decision.

SECTION 8

PRINCIPAL THREAT WASTE

The NCP establishes an expectation that EPA will use treatment to address the principal threats posed by a site wherever practicable. Principal threat wastes are those source materials considered highly toxic or highly mobile that generally cannot be reliably contained, or would present a significant risk to human health or the environment should exposure occur. Remedies involving treatment of principal threat wastes will satisfy the statutory preference for treatment as a principal element.

At the LSGPS, principal threat wastes are found in the contaminated vadose zone soil at the Beall property and in the contaminated vadose and saturated zones soil at the Brenntag property. The known lateral limits of source material (soil with contaminant concentrations above proposed remediation goals) are shown in Figure 6 (Beall Source Area) and Figure 7 (Brenntag Source Area). For the purposes of Feasibility Study estimations, the volume of source material has been tentatively estimated at 16,437 cubic yards in the Beall Source Area and 3,865 cubic yards in the Brenntag Source Area. These estimates include contaminated soil under structures.

The limits of the identified source material have not been fully defined and additional source material is likely present in both source areas. Lateral and vertical limits of source material will be further delineated during Remedial Design.

Alternatives 3 and 8 include excavation and thermal treatment of the contaminated soil at the Beall Source Area. Alternatives 3, 6, and 8 include excavation and thermal treatment of the contaminated soil at the Brenntag Source Areas. Excavation and thermal treatment provide a direct and rapid means of contaminant destruction. Alternatives 5, 6, and 7 include soil vapor extraction of the contaminated soil at the Beall Source Area. Alternatives 5 and 7 include soil vapor extraction of the contaminated vadose soil at the Brenntag Source Areas. Both excavation and thermal treatment and soil vapor extraction are EPA presumptive remedies for chlorinated solvent contamination in soil. Soil vapor extraction is not as reliable and has longer remediation time frames than excavation and thermal treatment but is a viable alternative for under existing structures. Table 22 summarizes the remedy components for each alternative.

SECTION 9

SELECTED REMEDY

DEQ and EPA have determined that the preferred remedial alternative presented in the Proposed Plan, Alternative 6, with slight modifications, is the appropriate remedy for the site, based upon consideration of CERCLA requirements, the detailed analysis of alternatives, and public comments.

9.1 Summary of the Rationale for the Selected Remedy

DEQ and EPA selected Alternative 6, with slight modifications, for the remedy over the other alternatives because of the expectation that Alternative 6 with the site wide components will meet all Remedial Action Objectives and ARARs within the shortest amount of time for the lowest cost. The treatment options permanently destroy contaminants to achieve risk reduction to concentrations below proposed remediation goals in all environmental media. Based on the information available at this time, the DEQ and EPA believe the Selected Remedy will be protective of human health and the environment, comply with ARARs, be cost-effective, and utilize permanent solutions, presumptive remedies, and alternative treatment technologies to the maximum extent practicable. Because it would treat both the source materials constituting the principal threats and the groundwater, this remedy also would meet the statutory preference for the selection of a remedy that involves treatment as a principal element.

The Selected Remedy will reduce risk to human health and the environment through the following:

- The Selected Remedy will meet the threshold cleanup evaluation criteria of overall protection of human health and the environment, and compliance with ARARs. The remedy accomplishes overall protection through removal and destruction of contaminants from subsurface soil, in-situ destruction of contaminants in groundwater and saturated soil, and implementation of institutional controls. Institutional controls prevent use of contaminated aquifers for domestic purposes, prevent migration of contaminated groundwater due to excessive withdrawal, provide community information and education, require site monitoring, and describe procedures for immediate protection of human health for area residents and workers.
- The Selected Remedy removes or treats the principal contaminant sources at the site. The Selected Remedy also satisfies the statutory preference for treatment as a principal element of the remedy (reduces the toxicity, mobility, or volume of hazardous substances as a principal element through treatment).
- The Selected Remedy provides very good long-term effectiveness and permanence because accessible contaminated soil will be excavated and treated, contaminants in vadose soil beneath structures and at depth will be removed through soil vapor extraction, and contaminants in saturated soil and groundwater will be treated in-situ by chemical oxidation and bioremediation. Contaminated groundwater plumes will be reduced in magnitude and extent through source removal and treatment, barriers, and bioremediation. Groundwater cleanup will reduce impacts to surface water.
- The Selected Remedy is readily implementable. The selected cleanup technologies have been successfully implemented at other Superfund sites and no technical or administrative difficulties are foreseen. Design studies will be required to fully define the areas of contamination where the remedies will be implemented and to optimize the selected technologies. Remedial Design may also consider alternative technologies determined by DEQ and EPA to be equally effective in achieving performance criteria as set forth in this Record of Decision.

DEQ and EPA have determined that the Selected Remedy best meets the selection criteria and the appropriate balance considering site-specific conditions and criteria identified in CERCLA and the NCP (additional documentation is provided in Part 2, Section 10).

9.2 Detailed Description of the Selected Remedy

The Selected Remedy is outlined below. The remedy may change somewhat as a result of Remedial Design and construction processes. Changes to the remedy will be documented using a technical memorandum in the Administrative Record, an explanation of significant differences, or a Record of Decision amendment, in accordance with the NCP and EPA guidance. For the purposes of the following descriptions, “contaminated soil” and “contaminated groundwater” are soil and groundwater that contain contaminant concentrations above remediation goals as shown on Table 1 and Table 2.

Site-Wide Elements

- Long-Term Groundwater Monitoring. The person(s) implementing the remedy will develop a plan, to be approved by DEQ and EPA, during Remedial Design for monitoring site media during remedy construction and long-term operation and maintenance. This plan will include sampling and analysis to confirm the satisfactory performance of the remedy, to ensure protection of human health and the environment during remedy implementation, to verify attainment of cleanup standards, to confirm achievement of Remedial Action Objectives, and to verify compliance with ARARs.
- 5-year CERCLA reviews. DEQ and EPA will conduct a statutory review within five years after initiation of Remedial Action to ensure that the remedy is, or will be, protective of human health and the environment. This review is necessary because the Selected Remedy will result in hazardous substances, pollutants, or contaminants remaining on-site above levels that allow for unlimited use and unrestricted exposure. This review will be performed at least every five years as necessary under the requirements of the NCP and EPA guidance.
- Institutional controls. Non-engineered restrictions, such as administrative and / or legal controls upon the use of property that help to minimize the potential for human exposure to contamination or protect the integrity of a remedy necessary when sites cannot be cleaned up to allow unrestricted use. The following institutional controls will be implemented:

Groundwater Use Restrictions. (Controlled Groundwater Area) The person(s) implementing the remedy will coordinate with EPA, DEQ and the Yellowstone City/County Health Department to prepare and supply adequate supporting information for a petition by the Yellowstone City/County Health Department to the Department of Natural Resources and Conservation (DNRC) to establish a Controlled Groundwater Area under Title 85, Chapter 2, Part 5 MCA for the LSGPS. The basis of this petition is that excessive groundwater withdrawals would cause contaminant migration or that water quality within the groundwater area is not suited (for example, contaminant concentrations are above MLCs) for a specific beneficial (domestic) use. The Controlled Groundwater Area will extend past the outer extents of the contaminant plume to create a buffer zone to ensure the plume does not expand through significant withdrawals of groundwater near the plume boundaries and to provide a zone of protection. Groundwater monitoring would be used to track plume concentrations until cleanup levels are met. If granted, the DNRC will enforce its corrective control provisions as set forth under Section 85-2-507, MCA. If the Controlled Groundwater Area is not approved by the DNRC, the remedy will require the placement of other appropriate institutional controls to prevent or limit groundwater withdrawals from the area. DEQ and EPA will evaluate sampling results and model potential contaminant migration as necessary. These corrective control provisions will be put in place before Remedial Action commences and will remain until cleanup standards are met within the Site.

Deed Notices/Deed Restrictions. The person(s) implementing the remedy will coordinate with the property owner(s) of the source properties and properties where engineered components of the remedy have been or will be constructed, in preparing and filing a deed notice/deed restriction under Section 75-10-727, MCA, satisfactory to DEQ and EPA, that describes the remedial work done on the properties and places restrictions on the use of the

property sufficient to prevent interference with the engineered remedial components located on the property until cleanup levels are met. These deed notices/deed restrictions will be implemented before remedial construction has begun and will be maintained until cleanup standards are met within the Site.

Community Awareness/Education Program. The person(s) implementing the remedy shall, prior to commencement of remedial construction, in coordination with Yellowstone County and subject to the approval of DEQ and EPA, implement a long-term community awareness and education program informing the public of topics such as the health risks associated with the use of contaminated groundwater, the safe use of contaminated well water for certain purposes, measures to reduce the risks from contaminated vapors in indoor air, remedial components, construction and monitoring schedule, and potential impacts to the community. This community awareness and education program will be updated continuously and remain in place until the cleanup standards are met within the Site.

- Risk Mitigation Measures. The person(s) implementing the remedy shall monitor contaminant concentrations in groundwater and indoor air and, when necessary as determined by DEQ and EPA, provide immediate protection of human health for area residents and workers. DEQ and EPA will approve a long-term groundwater and indoor air monitoring plan to include contingencies for immediate protection of human health. Such contingencies may include but are not limited to active indoor air mitigation systems and the provision of a permanent potable water supply.

Beall Source Area Groundwater and Plume Leading Edge

- An enhanced bioremediation system will be implemented at the Beall Source Area to treat contaminated groundwater to cleanup levels. The approximate area to be treated is that portion of the plume upgradient of US Highway 87 East shown in Figure 10. Design studies will be conducted to determine effective and practical methods for implementing this system and the location and configuration of the system. The design will consider, but will not necessarily be limited to, a recirculation treatment system in the source area that would inject amendments such as sodium lactate to promote anaerobic degradation. Groundwater will be monitored for degradation parameters and volatile organic compounds (VOC). Batch delivery of amendments to the aquifer will be repeated as necessary to degrade PCE, TCE, cis-1,2-DCE, and VC until cleanup levels are achieved throughout the plume. Groundwater and system performance monitoring will be conducted using a network of existing wells, and new wells if necessary. The selection of monitoring parameters and frequencies will be developed during Remedial Design.
- An enhanced bioremediation system will be implemented to treat contaminated groundwater to cleanup levels at and downgradient of the Beall Source Area groundwater plume leading edge. The approximate location of the plume leading edge is shown in Figure 10. Design studies will be conducted to determine effective and practical methods for implementing this system and the location and configuration of the system. The design will consider, but will not necessarily be limited to, an enhanced bioremediation system that would use a series of injection wells configured in a treatment zone across the plume width at the leading edge of the plume. The treatment zone will be installed to provide treatment of the downgradient edge of the plume to inhibit further migration of the plume leading edge. During the initial phase of remediation, amendments to promote and enhance biodegradation would be injected at the treatment zone. Groundwater will be monitored for degradation parameters and VOCs. Batch delivery of amendments to the aquifer will be repeated as necessary to degrade PCE, TCE, cis-1,2-DCE, and VC until cleanup levels are achieved throughout the plume. Groundwater and system performance monitoring will be conducted using a network of existing wells, and new wells if necessary. The selection of monitoring parameters and frequencies will be developed during Remedial Design.

Beall Source Area Soil

- A soil vapor extraction system will be constructed at the Beall Source Area to treat contaminated vadose soil to cleanup levels. The approximate locations of Beall Source Area contaminated vadose soil are shown in Figure 11. Design studies will be conducted to determine effective and practical methods for implementing this system and the location and configuration of the system. The design studies will include additional sampling to fully delineate areas where soil contaminant concentrations are above cleanup levels. The design will ensure treatment is achieved from ground surface to the water table (approximately 45 feet deep). The system design will also ensure that treatment is achieved in areas where contaminated soil is suspected including beneath the former steam clean bay building, along piping beneath the building, and along piping running from the building to the former oil-water separator and leach field. Optimal well spacing, screened interval placement, and flow rate selection for Remedial Design will be determined through design studies. Soil vapor extraction vapor discharge will be treated as necessary to comply with air quality standards.

Brenntag Source Area Groundwater

- A permeable reactive barrier (or other treatment/containment barrier technology determined by DEQ and EPA during Remedial Design to be equally effective in achieving performance criteria as set forth in this Record of Decision) will be constructed immediately downgradient of the Brenntag Source Area to treat contaminated groundwater to cleanup levels downgradient of the barrier. Design studies will be conducted to determine effective and practical methods for implementing the selected system and the location and configuration of the system. The location of the barrier will be downgradient of identified NAPL-contaminated source areas shown in Figure 10. The barrier will be constructed across the entire width of the groundwater plume in this area, estimated at 325 feet in width. The barrier will be designed to treat groundwater throughout the saturated thickness (approximately 25 feet). Contaminated groundwater passing through the barrier system will be treated to reduce VOC concentrations to meet cleanup levels. Groundwater and system performance monitoring will be conducted using a network of existing wells, and new wells as determined by DEQ and EPA. The selection of monitoring parameters and frequencies will be developed during Remedial Design.
- An enhanced bioremediation system will be implemented upgradient of the treatment barrier to treat contaminated groundwater to achieve cleanup levels. Construction of this system should follow completion of Brenntag Source Area soil excavation and in-situ chemical oxidation portions of the remedy (see below). Design studies will be conducted to determine effective and practical methods for implementing this system and the location and configuration of the system. The design will consider, but will not necessarily be limited to, a recirculation treatment system in the source area that would inject amendments such as sodium lactate to promote anaerobic degradation. Groundwater will be monitored for degradation parameters and VOC. Batch delivery of amendments to the aquifer will be repeated as necessary to degrade PCE, TCE, cis-1,2-DCE, and VC until cleanup levels are achieved throughout the plume. Groundwater and system performance monitoring will be conducted using a network of existing wells, and new wells if necessary. The selection of monitoring parameters and frequencies will be developed during Remedial Design.
- An enhanced bioremediation system will be implemented downgradient of the treatment barrier to treat contaminated groundwater to achieve cleanup levels in groundwater. Design studies will be conducted to determine effective and practical methods for implementing this system and the location and configuration of the system. The design will consider, but will not necessarily be limited to, an enhanced bioremediation system that would use a series of injection wells configured in a treatment zone across the plume width. The treatment zone will be installed to provide treatment of the plume between the treatment barrier and the downgradient edge of the plume at the Yellowstone River. During the initial phase of remediation, amendments to promote and enhance biodegradation would be injected at the treatment zone. Groundwater will be

monitored for degradation parameters and VOCs. Batch delivery of amendments to the aquifer will be repeated as necessary to degrade PCE, TCE, cis-1,2-DCE, and VC until cleanup levels are achieved throughout the plume. Groundwater and system performance monitoring will be conducted using a network of existing wells, and new wells if necessary. The selection of monitoring parameters and frequencies will be developed during Remedial Design.

Brenntag Source Area Soil

- Accessible contaminated vadose and saturated soil at the Brenntag Source Area will be excavated and treated to achieve cleanup levels using low temperature thermal treatment. Accessible soil is considered soil in those areas where conventional excavation can be conducted without adversely affecting facility permanent foundations and equipment. Estimated soil remediation areas are shown on Figure 11. Design studies will be conducted to determine effective and practical methods for implementing this portion of the remedy. Design studies will include additional sampling to fully delineate areas where soil contaminant concentrations are above cleanup levels. Soil will be excavated from ground surface to the bottom of the fine-grain silty sand unit, an estimated average of 14 feet below ground surface. Sheet piling may be necessary for slope stabilization during excavation. Shallower excavations, setbacks, and sloped excavations should be used near foundations and equipment. Concurrent injection of chemical oxidants may be considered to treat inaccessible contaminated saturated soil during the excavation process. Soil treatment equipment will be temporarily located within the immediate vicinity of the Brenntag Source Area. Thermal treatment vapor discharge will be treated as necessary to comply with air quality standards. Excavation areas will be backfilled with treated soil, if feasible.
- A soil vapor extraction system will be constructed to treat inaccessible contaminated vadose soil at the Brenntag Source Area to achieve cleanup levels. Inaccessible soil is considered soil beneath and immediately adjacent to facility permanent foundations and equipment that cannot be excavated using conventional methods without adversely affecting those facilities. In the southeastern portion of the Brenntag facility, one area of soil contamination is beneath a portion of a tank storage area (Figure 11). Design studies will be conducted to determine effective and practical methods for implementing this system and the location and configuration of the system. The design studies will include additional sampling to fully delineate areas where soil contaminant concentrations are above cleanup levels. The design will ensure treatment is achieved from ground surface to the water table (approximately 10 feet deep). The system design will also ensure that treatment is achieved in inaccessible areas where soil sampling may be difficult or infeasible and contaminated soil is suspected. Optimal well spacing, screened interval placement, and flow rate selection will be determined through design studies. Soil vapor extraction vapor discharge will be treated as necessary to comply with air quality standards.
- In-situ chemical oxidation will be implemented at the Brenntag Source Area to treat inaccessible contaminated saturated soil and other contaminated soil and contaminated groundwater areas where contaminant sources are known or suspected. Design studies will be conducted to determine effective and practical methods for implementing this portion of the remedy. Design studies will include additional sampling to fully delineate treatment areas where soil contaminant concentrations are above cleanup levels or otherwise where contaminant sources are located. Design studies will determine the type of chemical oxidant, which may include but is not limited to sodium permanganate, ozone, or hydrogen peroxide. Contaminated areas will likely require multiple injection phases, particularly in areas where suspected NAPL or other organic contaminants, such as petroleum or methanol, may be present, because these conditions create a high chemical-oxidant demand. Injection spacing may be increased in areas of high concentrations due to faster contaminant reaction rates, which lead to more limited transport distances from the injection site. Pressurized injection may also be employed to obtain better lateral transport using higher oxidant concentrations, resulting in fewer injection points.

Site-Wide Groundwater

- An enhanced bioremediation system will be implemented to treat contaminated groundwater to cleanup levels in site-wide groundwater areas. The location of contaminated groundwater outside the Beall and Brenntag Source Areas is shown on Figure 10. Design studies will be conducted to determine effective and practical methods for implementing this system and the location and configuration of the system. The design will consider, but will not necessarily be limited to, an enhanced bioremediation system that would use a series of injection wells configured in treatment zones across the plume in one or more locations between the Beall and Brenntag Source Areas. The locations of treatment zones for costing projections are shown on Figure 10. During the initial phase of remediation, amendments to promote and enhance biodegradation would be injected at the treatment zone. Groundwater will be monitored for degradation parameters and VOCs. Batch delivery of amendments to the aquifer will be repeated as necessary to degrade PCE, TCE, cis-1,2-DCE, and VC until cleanup levels are achieved throughout the plume. Groundwater and system performance monitoring will be conducted using a network of existing wells, and new wells if necessary. The selection of monitoring parameters and frequencies will be developed during Remedial Design.

Remedial Action Objectives and Performance Standards

DEQ and EPA have established Remedial Action Objectives for each contaminated medium as detailed in Part 2, Section 5.

The Remedial Action Objectives for groundwater and surface water are:

- Prevent exposure of humans to groundwater and surface water contaminants in concentrations above regulatory standards.
- Reduce contaminant concentrations in the alluvial aquifer and surface water to below regulatory standards.
- Prevent or minimize further migration of the contaminant plume (plume containment).

The Remedial Action Objective for soil is:

- Prevent or minimize further migration of contaminants from source materials (soil) to groundwater (source control).

Performance standards of 5 µg/L for PCE and TCE, 70 µg/L for cis-1,2-DCE, and 2 µg/L for VC in groundwater will meet the MCLs identified as ARARs. Table 1 and Table 2 summarize groundwater and soil remediation goals. Part 2, Section 3.4.2.2 details the development of site-specific soil screening levels and remediation goals.

9.3 Cost Estimate for the Selected Remedy

Tables 26 and 27 summarize capital, operation and maintenance, and periodic costs for the Selected Remedy. Table 28 summarizes the 30-year present value analysis. Appendix A presents detailed summaries of the cost components. DEQ and EPA selected a permeable reactive barrier for the treatment barrier at Brenntag, hydrogen peroxide for in-situ chemical oxidation, and anaerobic/aerobic enhanced bioremediation. The cost estimate is based on estimates provided through Remedial Action Cost Engineering and Requirements (RACER 2003) and vendor quotes when available and is current for 2003.

The net present value of construction, operation, and maintenance of the Selected Remedy for a 30-year period is approximately \$14,347,900. DEQ and EPA developed these cost estimates based on the best available information regarding the anticipated scope of the remedy and on cost information presented in the Feasibility Study (TtEMI 2004) and Proposed Plan (DEQ 2004). This is a feasibility-level engineering

cost estimate expected to be within +50 to -30 percent of the actual project cost. Changes in the cost elements are likely to occur as a result of new information and data collected during engineering design.

9.4 Estimated Outcomes of Selected Remedy

The overall site remedy uses a combination of institutional controls and soil and groundwater treatments to control exposures and protect human health and the environment over the long term. The remedy is expected to reduce contaminant concentrations in vadose and saturated soil through a combination of technologies to clean up the Beall and Brenntag Source Areas, prevent migration of contaminated groundwater from the source areas, and accelerate cleanup of the contaminated groundwater that has already migrated downgradient of the source areas. The technologies selected by DEQ and EPA to meet the remedy requirements include a combination of excavation and thermal treatment, a permeable reactive barrier, soil vapor extraction, in-situ chemical oxidation, and in-situ bioremediation. After soil treatments are completed, leaching of contaminants that remain in soil at concentrations below cleanup levels is not expected to cause groundwater cleanup standards to be exceeded. Excavation and thermal treatment provide a direct and rapid means of contaminant destruction for accessible contaminated soil at the Brenntag Source Area. Soil vapor extraction is not as reliable and has longer remediation time frames than excavation and thermal treatment but is a viable alternative for inaccessible, deep soil at the Beall Source Area and inaccessible soil under existing structures at both source areas. Groundwater treatment is achieved through installation of a permeable reactive barrier (or other treatment/containment barrier technology determined by DEQ and EPA during Remedial Design to be equally effective in achieving performance criteria as set forth in this Record of Decision) and by in-situ bioremediation. Successful remediation of source area soil and groundwater will reduce the cost and timeframe required to operate and maintain downgradient barrier and in-situ bioremediation treatment. For example, successful remediation of the Brenntag Source Area soil and groundwater could eliminate the need to replace a permeable reactive barrier after one life cycle (estimated to be 15 years), resulting in a capital cost savings of approximately \$1.6 million. After completion of both soil and groundwater treatments, groundwater contaminant concentrations are expected to be at or below regulatory standards for potable use and soil contaminant concentrations will be below levels of concern for protection of groundwater. Institutional controls will prevent or mitigate exposures to contaminated groundwater during implementation of soil and groundwater treatment and until cleanup levels are achieved. Surface water cleanup will be achieved as a result of groundwater cleanup in those areas where groundwater recharge to surface water is occurring.

After DEQ and EPA issue the Record of Decision, it may take up to six years to complete Consent Decree negotiations, Remedial Design, and construction. After designs are complete and remedial components are constructed, current estimates indicate that groundwater and surface water downgradient of the Beall and Brenntag Source Areas will take approximately nine years to meet cleanup goals. Groundwater at the source areas will take longer to meet these goals.

Land uses are not expected to change as a consequence of the Remedial Action. Land use in the Beall and Brenntag Source Areas is expected to remain light industrial and commercial. Mixed land use elsewhere at the site (residential, commercial, light industrial, and recreational) is also expected to remain mixed.

Groundwater use will be restricted by institutional controls during implementation of the remedy and these restrictions will remain in effect until cleanup levels are achieved. Groundwater use restrictions are necessary to prevent use of contaminated groundwater and to minimize impacts to or migration of contaminated groundwater that could occur by adjacent or nearby groundwater withdrawals. After groundwater cleanup levels are achieved, groundwater may again be available for unrestricted use. The timeframe for achieving groundwater cleanup levels throughout the plume are uncertain but are expected to be met within 30 years. Portions of site groundwater outside source areas may meet cleanup levels sooner than within the source areas. Unrestricted use of groundwater outside source areas may be allowed prior to complete cleanup of the source areas if these uses would not cause adverse migration of remaining contamination.

Final cleanup levels for soil and groundwater are presented in Table 29, Table 30, and Table 31.

Site cleanup is expected to have a moderately positive local socio-economic impact. A short-term increase in local jobs is expected during construction and operation and maintenance. Site cleanup can be expected to result in increased property values and tax revenues.

Site contaminants were not found to pose an unacceptable risk to ecological receptors, but the removal and/or destruction of contaminants in water and solid media are expected to produce a positive environmental effect.

SECTION 10

STATUTORY DETERMINATIONS

Under CERCLA Section 121 and the NCP, DEQ and EPA must select remedies that are protective of human health and the environment, comply with ARARs (unless a statutory waiver is justified), are cost effective, and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. In addition, CERCLA includes a preference for remedies that employ treatment that permanently and significantly reduce the volume, toxicity or mobility of hazardous wastes as a principal element and a bias against off-site disposal of untreated wastes. The following sections discuss how the Selected Remedy meets these statutory requirements.

10.1 Protection of Human Health and the Environment

The Selected Remedy for remediation at the LSGPS will protect human health and the environment through a combination of technologies to clean up the Beall and Brenntag Source Areas, prevent migration of contaminated groundwater from the source areas, and accelerate cleanup of the contaminated groundwater that has already migrated downgradient of the source areas. Soil vapor extraction will be used to treat shallow contaminated soil at Beall and inaccessible vadose soil at the tank farm area at Brenntag. Accessible, shallow contaminated soil will be excavated and thermally treated at Brenntag. Inaccessible, saturated contaminated soil in the source areas will be treated through in-situ chemical oxidation at Brenntag. Contaminated groundwater within the Beall and Brenntag Source Areas will be treated in place with enhanced bioremediation. A permeable reactive barrier (or other treatment/containment barrier technology determined by DEQ and EPA during Remedial Design to be equally effective in achieving performance criteria as set forth in this Record of Decision) will be constructed immediately downgradient of the Brenntag Source Area to treat contaminated groundwater to cleanup levels downgradient of the barrier. Contaminated groundwater that has already migrated to areas outside of the source areas and is present site-wide will be treated by enhanced bioremediation followed by monitored natural attenuation.

The Selected Remedy does not produce unacceptable short-term risks. The components of the remedy can be constructed within about one year. Such risks as worker safety, disruption of residents, and community safety can be readily controlled through careful planning. In addition, no adverse cross-media impacts are expected from the Selected Remedy. Thermal treatment and soil vapor extraction systems are considered easy to operate, although to prevent cross-media impacts, granular activated carbon filters or equivalent technologies may need to be used and air discharge limits will need to be met.

10.2 Compliance with Applicable or Relevant and Appropriate Requirements

DEQ's and EPA's final determination of ARARs is included in Appendix B. The Selected Remedy will comply with all ARARs. Key requirements for the LSGPS are state and federal contaminant-specific ARARs for groundwater and surface water. These ARARs set concentrations of contaminants of concern that may be allowed in or discharged into the environment. There are no state or federal contaminant-specific soil quality standards. DEQ and EPA have set site-specific remediation goals for contaminants in soil that will prevent or minimize further migration of contaminants from soil to groundwater. These goals will be met under the Selected Remedy.

The Selected Remedy is designed to treat principal threat wastes in source areas and to contain (prevent further migration) and treat groundwater to a level that will allow the processes of natural attenuation to complete the restoration of the groundwater and surface water to below regulatory standards. After designs are complete and remedial components are constructed, current estimates indicate that groundwater and surface water downgradient of the Beall and Brenntag Source Areas will take approximately nine years to meet ARARs. Groundwater at the source areas will take longer to meet these standards.

10.3 Cost-Effectiveness

The estimated present worth cost of the Selected Remedy is \$14,347,900. The Selected Remedy was chosen over other alternatives because it is expected to meet all Remedial Action Objectives and ARARs within the shortest amount of time for the lowest cost. Lower cost alternatives may not meet contaminant-specific ARARs for groundwater and surface water. The Selected Remedy is the least expensive of the alternatives that meet all ARARs. In DEQ's and EPA's judgment, the Selected Remedy is cost-effective and represents a value for the money to be spent. In making this determination, the following definition was used: "A remedy shall be cost-effective if its costs are proportional to its overall effectiveness." (NCP § 300.430(f)(1)(ii)(D)). This was accomplished by evaluating the "overall effectiveness" of those alternatives that satisfied the threshold criteria (were both protective of human health and the environment and ARAR-compliant). Overall effectiveness was evaluated by assessing three of the five balancing criteria in combination (long-term effectiveness and permanence; reduction in toxicity, mobility and volume through treatment; and short-term effectiveness). Overall effectiveness was then compared to costs to determine cost-effectiveness. Detailed evaluation may be found in the Feasibility Study (TtEMI 2004). The relationship of the overall effectiveness of this remedial alternative was determined to be proportional to its costs and hence this alternative represents a value for the money to be spent.

10.4 Utilization of Permanent Solutions and Alternative Treatment Technologies (or Resource Recovery Technologies) to the Maximum Extent Practicable

The Selected Remedy permanently reduces the toxicity, mobility, and volume of contaminants at the LSGPS through treatment of soil and groundwater, followed by monitored natural attenuation of site-wide groundwater. The treatment options permanently destroy contaminants to achieve risk reduction to concentrations below remediation goals in all environmental media. No off-site treatment or disposal is contemplated under the Selected Remedy, except for residual treatment wastes such as granular activated carbon. The Selected Remedy will treat approximately 136 million gallons of contaminated groundwater by permanently destroying or removing contaminants from the groundwater aquifer. The Selected Remedy will excavate and thermally treat approximately 2,400 cubic yards of contaminated soil. Contaminants will be destroyed in-situ through chemical oxidation and removed from the soil with soil vapor extraction. Removal and thermal treatment of soil source material will greatly reduce the mobility of contaminants migrating from the vadose and saturated soil to groundwater. The mobility of contaminants in groundwater will be restricted through the use of permeable reactive barrier (or other treatment/containment barrier technology determined by DEQ and EPA during Remedial Design to be equally effective in achieving performance criteria as set forth in this Record of Decision) and destroyed through the use of enhanced bioremediation. Use of these treatment technologies will permit the site-wide groundwater to restore itself through monitored natural attenuation. DEQ and EPA have determined that the Selected Remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized in a practicable manner at the site.

Of those alternatives that are protective of human health and comply with ARARs, DEQ and EPA have determined that the Selected Remedy provides the best option in terms of the five balancing criteria, while also considering the statutory preference for treatment as a principal element and bias against off-site treatment and disposal. The Selected Remedy has received both Support Agency and Community Acceptance.

10.5 Preference for Treatment as a Principal Element

The Selected Remedy treats the source materials and groundwater constituting principal threats at the site, achieving significant reductions in contamination in soil and groundwater to below risk-based standards and regulatory standards. Because it would treat both the source materials constituting principal threat wastes and the groundwater at the LSGPS, the Selected Remedy meets the statutory preference for the selection of a remedy that involves treatment as a principal element.

10.6 Five-Year Review Requirements

The Selected Remedy will result in hazardous substances, pollutants, or contaminants remaining on-site for more than five years above levels that allow for unlimited use and unrestricted exposure. Therefore, DEQ and EPA will conduct a statutory review within five years after initiation of Remedial Action (and no less often than each five year period thereafter) to ensure that the remedy is, or will be, protective of human health and the environment.

SECTION 11

DOCUMENTATION OF SIGNIFICANT CHANGES FROM THE PREFERRED ALTERNATIVE OF THE PROPOSED PLAN

There are no significant changes from the Preferred Alternative identified in the Proposed Plan to the Selected Remedy detailed in this Record of Decision.

SECTION 12

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PART 3
RESPONSIVENESS SUMMARY

PART 3

RESPONSIVENESS SUMMARY

The Responsiveness Summary provides a summary of the public's view regarding the remedial alternatives and general concerns about the site submitted during the public comment period for the Proposed Plan.

DEQ and EPA released the Proposed Plan (DEQ 2004) for public comment on November 15, 2004, and accepted written comments through January 14, 2005. DEQ and EPA held a public meeting and hearing on Thursday, December 2, 2004, at the Lockwood School. DEQ and EPA presented the Preferred Alternative and moderated the public hearing during which two members of the public verbally submitted comments, recorded by a court reporter, on the Proposed Plan (Big Sky Reporting 2004). Eight separate parties submitted written comments to DEQ before January 14, 2005. The public comments are summarized below; complete submissions are available in the Administrative Record. DEQ and EPA responses are immediately following the comment.

Commenter #1: Supports the Preferred Alternative.

1. What prevents contaminants from continuing to flow downgradient from the Beall Source Area?

Response: The Selected Remedy includes a treatment system to cut-off the migration of contaminants from the source area and also treats the groundwater at the leading edge of the plume.

2. Does the reactive barrier need to be replaced every 15 years in the future?

Response: If constructed of zero-valent iron, the permeable reactive barrier at the Brenntag property will most likely need to be replaced every 15 years. Any other equivalent treatment/containment barrier technology selected will most likely require routine maintenance. In any case, the barrier is in place to hinder the downgradient migration of contaminated groundwater from the Brenntag Source Area. The life of the barrier depends upon the success of remediation activities at the Brenntag Source Areas.

3. Why is air sparging not included in the Preferred Alternative? Is bioremediation more effective and reliable than air sparging?

Response: Air sparging is an option available for saturated soil below the water table. For the LSGPS, DEQ and EPA have determined that air sparging is not the best alternative for remediation of saturated soil. For the groundwater that has migrated downgradient of the Brenntag Source Area, enhanced bioremediation will remediate both saturated soil and groundwater in less time and more effectively than air sparging.

4. Will there be consideration to clean up a specific residential property first or sooner than one year?

Response: No. The remedial approach for the LSGPS does not include remediation of individual residential properties. The approach includes source control and treatment with aggressive remediation of contaminated groundwater throughout the site. There are no identified sources of contamination on residential properties. The contaminants present at the site and the release mechanisms do not support the remediation of individual properties.

5. Will the soil at a specific residential property be excavated?

Response: No. Only the two source areas (Beall and Brenntag) contain soil contaminated above remediation goals. Therefore, soil at individual residential properties will not be excavated, as they are not source material for migration of contamination nor do they pose a human health risk for residents.

6. When will construction begin?

Response: After issuing the Record of Decision, DEQ and EPA will begin Consent Decree negotiations with the Responsible Parties for Remedial Design and Remedial Action. The actual date of construction depends on the length of reasonable, good faith negotiations and time to complete Remedial Design studies. DEQ and EPA estimate construction to begin within five years of issuance of the Record of Decision.

7. Will there be an extraction and injection well on a specific residential property?

Response: Possibly. The Selected Remedy does include injection wells downgradient of the Beall and Brenntag Source Areas, which may involve residential properties. DEQ and EPA will determine the exact locations of the injection wells during Remedial Design. DEQ and EPA will consult with the property owner as to the location and final construction of the wells on private property.

8. Will there be consideration to construct a shed over the well for visual impact and noise pollution?

Response: Yes. DEQ and EPA will consider reasonable requests of property owners to reduce potential inconvenience and detrimental impacts of certain technologies.

9. Who will be responsible for implementing the Proposed Plan?

Response: The Responsible Parties. DEQ and EPA will work with the Responsible Parties to design and implement the remedial components. DEQ and EPA will retain technical oversight and approval authority for all engineering designs, plans, and activities.

10. During the clean-up process, will there be any additional health threats? Do chemical oxidation and thermal treatments increase household vapors or any health threat?

Response: No. Based on numerous implementations of these technologies thoroughly studied by EPA in the past, DEQ and EPA do not expect the selected technologies to pose any health threats to the general public. Monitoring will be a part of the implementation and all efforts will be made to minimize and eliminate any potential health threats that may arise.

Commenter #2: Emphasized the fact that the Lockwood Water and Sewer District public water supply system was never impacted by the contamination. If natural attenuation is the remedy for the portion of the plume near the Water District wells, then the District will not be able to use the wells for quite some time. If the District turns on the wells, the wells will pull the plume towards the wells. Right now, the wells are a backup supply; however, in the case of emergency, the District will not be able to use the wells.

Response: The potential effect of future use of the District's wells will be considered as part of the establishment of the Controlled Groundwater Area (see Part 2, Section 9.2 of the Record of Decision).

Commenter #3:

1. Will there be pilot testing for the remedies?

Response: Yes. During the design phase, DEQ, EPA, or the Responsible Parties may propose and implement pilot tests as deemed necessary.

2. If there are meaningful questions received during the public comment period, will there be interaction with the public, a response provided to the public, and a period of time for the public to respond?

Response: Yes. DEQ and EPA have responded to all comments received during the public comment period in this Responsiveness Summary. DEQ and EPA have determined that there are no significant changes to the Preferred Alternative based on public comments received, and there is no need to issue a second Proposed Plan and solicit further public comment.

Commenter #4: Supports complete source removal, followed by aggressive site-wide remediation.

1. Given the fine-grained nature of the vadose zone at Beall Trailers, excavation and disposal of the solvent contaminated soil should be the preferred alternative. Vapor extraction will be slower, less effective, and may not meet site remediation goals.

Response: The contaminated soil at the Beall Source Area extends from the surface to the saturated zone, an average depth of 45 feet below ground surface. In addition, data suggests contaminated soil is present below the steam clean bay and associated sewer piping. Excavation is not practical to such depths or under buildings due to shoring and safety issues and structural stability of the buildings. Soil vapor extraction is considered an applicable remediation technology in soil with permeability greater than 10^{-10} square centimeters (cm^2) (Keller 2003). Soil at the Beall Source Area is expected to have a permeability within this range, similar to fine sand (10^{-8} cm^2) and clayey sand (10^{-9} cm^2). While cleanup timeframes are longer for tighter grained soil like that found in the Beall Source Area, contaminant concentrations in this area only slightly exceed remediation goals and are expected to meet these goals within five years after treatment begins.

2. Excavation and disposal should be the preferred alternative for all soil source areas at Brenntag. Excavation should include all contaminated soil in the vadose zone and all contaminated soil above the coarse grained aquifer material.

Response: In the northwest Brenntag Source Area, excavation and thermal treatment is the Selected Remedy. All contaminated soil feasibly removed will be excavated and thermally treated. In the tank farm area, excavation is not feasible based on the infrastructure, buildings and other structures, underground piping, and approximately 8 feet of "fly ash" fill.

3. Soil remediation goals are not low enough to ensure that groundwater contamination will not continue.

Response: DEQ performed site-specific fate and transport modeling detailed in Appendix D of the Feasibility Study (TtEMI 2004), as amended. The model results provide the site-specific soil remediation goals for the protection of groundwater. DEQ and EPA are confident the conservative values used in the model result in soil remediation goals that are protective of groundwater.

4. The Brenntag Facility is outdated, with ample visual and analytical evidence that degraded containment, spills, overfills, and leaks are a continual source of contamination. Regulatory agencies must require upgrades to the existing transfer, storage, off-loading, and delivery systems to prevent contamination of areas already undergoing remediation.

Response: Federal Superfund regulations do not include the day-to-day operation of facilities. The Administrative Rules of Montana set forth the regulations for the proper management of hazardous waste and used oil. Montana adopted, by reference, the used oil management rules promulgated by EPA in Part 279 of 40 CFR. DEQ's Permitting and Compliance Division enforce these regulations and perform routine inspections. Per a June 17, 2004 inspection report, DEQ's Permitting and Compliance Division noted Brenntag Pacific Inc. met the definition of a large quantity generator of hazardous waste for 2004 and a used oil generator and are not under a Corrective Action order at this time. Therefore, DEQ's Federal Superfund Program has referred this comment to DEQ's Permitting and Compliance Division.

5. The remedial selection should focus on elimination of all source soils and more aggressive enhanced biodegradation than that contemplated in the current preferred alternative. In this case, over excavation is the only clear and meaningful remediation.

Response: While over excavation is an aggressive and highly successful method of source remediation, it is not applicable to all source areas at the LSGPS. For example, both Beall and Brenntag have existing infrastructure on their properties that may potentially be destroyed or extensively damaged if soil was to be excavated from below those structures. Excavations to large depths create safety, shoring, and dewatering issues. Outside of the source areas, the vadose soil is not a source of contamination. There are other remedial options that are easily implemented and effective to adequately reduce soil contamination in those portions of the source areas. DEQ and EPA have composed an effective plan to remediate the multiple sources and migration pathways of contamination.

Commenter #5: Supports Alternative 7.

1. Under Alternative 7, contaminated groundwater at both source areas would get permeable reactive barriers, and the Beall area would also get a hydraulic barrier for treatment; while under Alternative 6 the only active groundwater remediation is a permeable reactive barrier for the Brenntag area.

Response: In addition to a barrier at Brenntag, the Selected Remedy includes treatment of contaminated groundwater that has migrated from the Beall Source Area (leading edge of plume) and treatment of Beall Source Area groundwater and site-wide groundwater with enhanced bioremediation. A permeable reactive barrier is difficult and very expensive to construct at the Beall Source Area in comparison to other, effective, remedial alternatives.

2. Alternative 7 would remediate saturated zone soils at both areas but Alternative 6 only for the Brenntag area.

Response: The Selected Remedy includes remediation of saturated soil in the Beall Source Area through enhanced bioremediation. In-situ chemical oxidation is included for the Brenntag Source Area.

3. Alternative 7 would actively remediate vadose zone soils at both areas.

Response: The Selected Remedy includes remediation of contaminated vadose zone soil by excavation and thermal treatment at the northwest Brenntag Source Area and soil vapor extraction at the Brenntag tank farm and at Beall.

4. Excavate shallow (vadose) soils at both source areas, to achieve more thorough treatment than in-situ (with maximum controls against volatilization and migration).

Response: The contaminated soil at the Beall Source Area extends from the surface to the saturated zone, an average depth of 45 feet below ground surface. In addition, data suggests contaminated soil is present below the steam clean bay and associated sewer piping. Excavation is not practical to such depths or under buildings. In the northwest Brenntag Source Area, all contaminated soil that may feasibly be removed will be excavated. However, excavation of saturated materials is difficult due to dewatering, depth, and shoring, therefore the saturated materials will be treated with in-situ chemical oxidation. In the Brenntag tank farm area, where excavation is not feasible based on the infrastructure, buildings and other structures, underground piping, and approximately 8 feet of "fly ash" fill, soil vapor extraction will be used to treat the soils.

5. It is critical to avoid thermal remediation techniques until DEQ is sure that halogen levels in the treated media are no higher than background levels to avoid the formation of dioxins and other highly toxic organochlorines. This is especially true for the Beall Source Area, given the historical presence of asphalt.

Response: The Selected Remedy does not include excavation and thermal treatment of soil at the Beall Source Area. The thermal treatment system will include carbon absorption units or oxidizers to capture or destroy organic air emissions emanating from the thermal treatment unit. Prior to full-scale treatment, performance tests will be conducted to ensure that the treatment unit meets all applicable standards including air quality requirements.

6. It appears that a few residents still drink water from wells in contaminated areas. Drinking water decisions should be based on the maximum contaminant level goal (MCLG), which is often much lower than the maximum contaminant level (MCL), frequently zero.

Response: DEQ and EPA sample all residential wells used for domestic purposes on a semi-annual basis. To date, all residences utilizing wells with contaminant concentrations above EPA's maximum contaminant levels have been provided the public water supply. MCLGs are non-enforceable public health goals. Once the MCLG is determined, EPA sets an enforceable standard: an MCL. The MCL is the maximum permissible level of a contaminant in water delivered to any user of a public water system. Thus, DEQ and EPA require remediation to achieve the MCL for each contaminant. The Selected Remedy includes continued monitoring of residential groundwater wells and provides for contingencies to ensure the continued protection of human health. If contaminant concentrations in a residential well exceed an MCL in the future, the residence will be provided a potable alternate water supply.

7. Dense non-aqueous phase liquids are the core reason for basic failure of the remediation paradigm. Please investigate use of co-solvent flushing DNAPL technique at Lockwood and other Montana DNAPL sites.

Response: While several lines of evidence suggest DNAPLs are present in the Brenntag Source Area, none of the historical investigations, including DNAPL ribbon sampling and soil sampling, were able to identify the location of mobile DNAPL at the LSGPS. Therefore,

remediation options that specifically target DNAPL source areas are not applicable to the LSGPS.

Commenter #6: Supports Alternative 7.

1. The chlorinated solvents contaminating the site are linked to disease, including cancer and developmental effects such as birth defects. Preventing even a single case of a birth defect saves money in long-term health costs. This should be considered in the decision.

Response: The LSGPS Risk Assessment evaluates both the potential cancer and non-cancer health impacts associated with the chlorinated compounds found at the site. The toxicity values used in risk assessment calculations are conservative and take into account sensitive populations, such as children and pregnant women. The LSGPS Risk Assessment used EPA's guidance, with a noncancer reference dose or inhalation reference concentration to protect a human liver and other noncancer endpoints. These are more sensitive endpoints than birth defect effects. The default exposure assessment takes into account a 70 kilogram person drinking 2 liters per day. A pregnant (gestating/lactating) woman is probably about that weight. Therefore, the reference dose, reference concentration, and default exposure assumptions used for the LSGPS Risk Assessment are protective against the most sensitive endpoint, including birth defects. The results of this LSGPS Risk Assessment were used in the decision process for the proposed remedy for the site.

2. While thermal treatment may be effective in removing chlorinated solvents from the soil, simply transferring the chlorinated compounds into the air, through the creation of dioxins, is not a solution to the problem. Please provide more information about the thermal treatment.

Response: The Selected Remedy uses low temperature thermal treatment to treat accessible contaminated soil at the Brenntag Source Area. There are a number of different types of thermal treatment systems and the most appropriate system, including an evaluation of dioxin production, will be determined during Remedial Design. The thermal treatment system will include carbon absorption units or oxidizers to capture or destroy organic air emissions emanating from the thermal treatment unit. Prior to full-scale treatment, performance tests will be conducted to ensure that the treatment unit captures or destroys organic air emissions to ensure the protection of the health of workers and residents.

Commenter #7:

Soil Preliminary Remediation Goals and Associated Modeling

1. Why are the Soil Preliminary Remediation Goals for the Beall Source Area 5 to 15 times lower than those for the Brenntag Source Area? Intuitively, it should be reversed since the Beall Source Area has approximately 40 feet of vadose zone with much of the soil column below the Brenntag Soil Preliminary Remediation Goals. Furthermore, the source area at the Beall Source Area is further removed from receptors than is the Brenntag Source Area.

Response: DEQ developed Preliminary Remediation Goals for soil using site-specific data and modeling when site data was not available. The model parameters used for the site-specific modeling (Appendix D and Appendix E, TtEMI 2004) resulted in hydraulic conductivity and mixing zone depth in the Beall Source Area aquifer that are about three times lower than the hydraulic conductivity and mixing zone depth for the Brenntag Source Area. These properties determine how quickly contaminants are diluted when they leach into groundwater. Leached contaminants are diluted about three times greater once they enter groundwater at the Brenntag Source Area than at the Beall Source Area; therefore contaminant levels can remain about three times higher in soil at the Brenntag

Source Area than at the Beall Source Area. These are the primary factors that resulted in lower soil preliminary remediation goals in the Beall Source Area.

2. The hydraulic conductivity selected for the Beall Source Area in the vadose zone model was lower than in the Brenntag Source Area. Although the hydraulic conductivity has been estimated from a "model calibration," there is no definitive field data that supports the value used in the Final Feasibility Study Report and/or that supports using different hydraulic conductivities for the two source areas. Given the current knowledge of site conditions, the use of different hydraulic conductivities is arbitrary. The vadose zone model, groundwater model, and associated dilution factors for the Beall Source Area should be recalculated. This uncertainty also has a significant impact on the design and associated costs for enhanced bioremediation.

Response: DEQ calculated the hydraulic conductivities for the Beall and Brenntag Source Areas through groundwater modeling, in part based on estimated contaminant transport from the source areas. DEQ then compared the calibrated model parameter values for hydraulic conductivity to the range of expected values for similar geologic conditions reported in the literature to ensure that the model values fell within an appropriate range for soil and geologic conditions at the site based on boring logs. DEQ considers these hydraulic conductivity values representative of site conditions (Appendix E, TtEMI 2004). While some uncertainty exists in the magnitude of hydraulic conductivity, DEQ does not consider this uncertainty significant and is within the range necessary to select an appropriate remedy for the site.

3. The infiltration rate selected for the Beall Source Area, primarily sandy lean clay, was higher than in the Brenntag Source Area, primarily sandy lean clay. Because the primary vadose zone soil at the Beall Source Area is predominately clay, the infiltration rate selected should be at least as low as Brenntag's infiltration rate, if not less. The vadose zone model and associated dilution factors for the Beall Source Area should be recalculated.

Response: DEQ reevaluated the vadose zone model (Appendix D, TtEMI 2004) and confirmed that an error was made in the infiltration rate calculations. For the purposes of these calculations, DEQ also determined there are no significant differences between vadose soil at the two source areas. Therefore, DEQ revised the soil modeling at both source areas using silty clay loam parameters and recalculated infiltration rates, dilution factors and cleanup levels (Appendix C). The recalculated cleanup levels (Table 2) are slightly higher for the Beall Source Area and slightly lower at the Brenntag Source Area than those originally calculated. The revised soil cleanup levels do not appreciably alter the estimated areas and volumes of contaminated soil requiring cleanup or the cost of the Selected Remedy.

4. Dual Equilibrium Desorption (DED) modeling should be considered.

Response: The Dual Equilibrium Desorption (DED) model is a new model developed by private industry to explain observations related to underground storage tank (UST) plumes and infers that the rate of contaminant desorption varies with contaminant concentration. While this modeling approach may have some merit, it is not currently recognized by DEQ or EPA as an appropriate substitute for EPA approved methodology. The modeling conducted as part of the Feasibility Study (TtEMI 2004) follows EPA's guidelines (EPA 1996) for determining soil cleanup levels and is considered adequate for the purposes of remedy selection.

Area of Soil Impact

1. Some of the soil samples identified as being above the soil remediation goal were collected at or below the saturated zone. The soil source area for the Beall Source Area west of the steam clean bay should be reduced by approximately half and the source area around MW012 should be eliminated.

Response: DEQ and EPA agree that some of the deeper soil samples could be considered in the saturated zone. However, removing the soil vapor extraction points from MW012 does not significantly impact the overall cost of the Selected Remedy and does not justify re-evaluation. The exact dimensions of contaminated soil and associated size of the soil vapor extraction system will be refined during Remedial Design. Subtraction of the other sample locations near the steam clean bay will not impact the overall area of the soil vapor extraction system. Other samples in close proximity to the steam clean bay exceed the soil remediation goals. DEQ and EPA did not sample immediately below the steam clean bay and associated piping and disposal tank components; however, the release mechanism for the contamination has been identified as the steam clean bay, piping, and tank components. Therefore, the soil vapor extraction system will encompass the soil below these components. Table 8 of this Record of Decision does not reflect concentrations from samples collected below 41' below ground surface, which may or may not be considered the saturated zone

2. As indicated in the ozone sparging/soil vapor extraction (OS/SVE) pilot test report (ATC 2003), the SVE portion of the test was ineffective due to low permeability clays in the vadose zone. How can SVE be implemented in the clays and be technically effective and cost-effective to prevent short-circuiting and limited radii of influences?

Response: The ATC pilot test was performed at the northwest Brenntag Source Area. Additional pilot test data submitted by Brenntag (ATC 2004) indicates that soil vapor extraction can effectively remove contaminants from the subsurface in the northwest Brenntag Source Area. The soil at Beall falls primarily within the fine sand and silt categories. Although soil vapor extraction is not considered as effective as excavation and thermal treatment, it is a feasible option in areas where excavation is impractical such as beneath facility permanent foundations and equipment. Therefore, soil vapor extraction is the Selected Remedy to treat inaccessible vadose soil.

3. The Feasibility Study (TtEMI 2004) indicates that guidelines for fine sand formations were used to calculate the radius of influence, flow rate, and vacuum anticipated for the soils beneath Beall Source Area. However, the soils beneath the Beall Source Area are clays with some lenses of sand and gravel (modeled as clays in the vadose zone model). Please resolve this inconsistency. In addition, please identify the methods proposed to prevent short-circuiting of airflow from the clays to the sand lens.

Response: According to well logs obtained during the Remedial Investigation from the Beall property, classification of vadose soil falls primarily within the fine sand and silt categories. Neither DEQ nor the Responsible Parties performed pilot tests at the Beall Source Area to determine soil vapor extraction design parameters; therefore DEQ used engineering estimates of soil vapor extraction performance in the Feasibility Study. These estimates are conservative, but consistent with the well logs and other engineering guidelines. For example, the soil vapor extraction well spacing of 16 feet used in the Feasibility Study (Keller 2003) is consistent with other guidelines of 22 feet for silty-clay formations (RACER 2003). The soil vapor extraction flow rate used in the Feasibility Study of 4 standard cubic feet per minute (scfm) per foot of vent screen (Keller 2003) is within the range of approximately 1 to 15 scfm per foot of vent screen recommended by other guidelines (RACER 2003). These design parameters will be refined during Remedial Design when pilot tests or design studies will be conducted. DEQ does not expect that

differences between the engineering estimates and design parameters will change the cost of the remedy significantly. Methods to optimize the effectiveness of the system (and prevent short-circuiting) will be determined during Remedial Design.

Alternative to SVE

1. Beall is requesting DEQ to consider an impermeable asphalt cover over the soil source area large enough in aerial extent to essentially eliminate precipitation in this area from infiltrating through the impacted vadose zone. By eliminating the opportunity for constituents to become mobile this will greatly reduce the potential to impact groundwater, and will reduce the time required to treat groundwater impacts.

Response: Horizontal barriers or caps could significantly reduce the rate of migration of contaminants from soil to groundwater due to infiltration of precipitation. However, sources would remain at and below the groundwater table and would continue to leach to groundwater in the source areas; therefore, Remedial Action Objectives would not be achieved in the source areas using caps alone. While an impermeable cap may not be used as an alternative to the soil vapor extraction system, impermeable caps are commonly used in combination with soil vapor extraction systems to prevent short-circuiting with atmospheric air. DEQ and EPA will evaluate the use of an impermeable cap in conjunction with the soil vapor extraction system during Remedial Design.

Groundwater Remediation

1. OS/SVE has been proven at the LSGPS to be effective in removing contaminants in a timely manner. The OS/SVE technology is not as prone to generating breakdown daughter byproducts like the selected enhanced bioremediation remedy selected for the Beall plume. The aquifer has a reported dissolved oxygen concentration greater than 1.0 milligrams per liter (mg/L) and appears to have a rapid and close by recharge. Why was the OS/SVE technology not selected for treatment of groundwater at the Beall plume? Has pulsing the treatment technologies been considered?

Response: Ozone sparging pilot tests for groundwater treatment at the Brenntag Source Area were inconclusive while pilot data indicated that soil vapor extraction treatment of vadose soil had some removal effectiveness (ATC 2004). In part, this is why DEQ did not select ozone sparge as a treatment technology at the Beall Source Area and selected soil vapor extraction instead. DEQ considered enhanced bioremediation a better remedy than ozone sparge for groundwater because it provides good treatment effectiveness at a lower cost. Alternative costs presented in the Feasibility Study (TtEMI 2004) indicate that ozone sparging would be more than twice as expensive as bioremediation. The appropriate method of enhanced bioremediation will be determined during Remedial Design to ensure all contaminants of concern and daughter products including vinyl chloride are treated. In addition, pulsing of the treatment technologies will also be evaluated during Remedial Design.

2. As indicated in the Feasibility Study the dissolved oxygen in groundwater is greater than 1.0 mg/L. The enhanced bioremediation vendor evaluation assumes the groundwater is anaerobic with dissolved oxygen less than 1.0 mg/L. With a highly permeable and fast moving aquifer like that found in the Beall plume with high dissolved oxygen content continuously flowing into the treatment zone, it will be difficult and costly to maintain adequate anaerobic conditions in the treatment area. The selected remedy for groundwater at the Beall site needs serious re-evaluation regarding the effectiveness, implementability, and cost-effectiveness.

Response: In-situ bioremediation has been successfully implemented at other similar sites, including sites with similar dissolved oxygen content and similar groundwater velocities. DEQ solicited an estimate from a bioremediation vendor, Regenesys, who has successfully

applied their bioremediation products at over 10,000 sites. The vendor evaluation assumed dissolved oxygen concentration in the Beall Source Area of 4.0 mg/L (not less than 1.0 mg/L as suggested) and indicated that their bioremediation approach could successfully remediate site groundwater. DEQ and EPA do not foresee any serious problems with successfully implementing this portion of the remedy.

3. For the Beall Source Area, other technologies need to be considered. Two examples are recirculation well systems and in-situ chemical oxidation. One type of in-situ circulation technology induces soil vapor extraction system for soil treatment while also remediating the groundwater via in-well air stripping in a single well. If needed, amendments like ozone could also be added in the recirculation well to enhance the oxidation of VOCs. Both soil and groundwater could be treated with one well decreasing the overall remediation costs.

Response: DEQ evaluated a broad range of technologies for the Feasibility Study (TtEMI 2004). These technologies included in-situ chemical oxidation, air sparging, and soil vapor extraction. In-well air stripping is a newly developing technology that provides treatment similar to air sparging. Based on the evaluation of these technologies, DEQ found that the Selected Remedy using soil vapor extraction and bioremediation has similar or better effectiveness at a lower cost.

4. The remedy needs to be pilot tested to assure the remedy will achieve the remediation goals effectively in a timely and cost-effective manner. The only pilot test run was the OS/SVE pilot test and it was concluded to be effective in reducing PCE. No pilot tests were performed on the selected enhanced bioremediation remedy in the Beall Source Area and based on the site conditions, for the reasons stated above, complete degradation to ethenes will be difficult to achieve in a timely and cost-effective manner. Hydraulic testing is needed to predict the effectiveness of groundwater recovery and injection as well as the design of such a system. Present estimates could be off by an order of magnitude, which will burden Beall and/or Brenntag with unwarranted increases in the overall remediation costs.

Response: Design studies will be conducted to determine the most effective and practical methods for implementing the remedy systems and the location and configuration of the systems. These design studies may include pilot tests and hydraulic testing if deemed appropriate.

5. Based on the potentiometric maps in the Feasibility Study, the Beall Source Area is located in a relatively flat if not mounded groundwater area. The groundwater may mound around the injection wells where the supplemented groundwater is proposed to be injected, and the injected water will flow away from the treatment area potentially even to the north and away from the recovery wells. It is strongly recommended that the effectiveness and implementability be reconsidered for the proposed enhanced bioremediation recirculation treatment system.

Response: Because injection and extraction occur simultaneously, there should be no net outflow of groundwater from the treatment area and consequently the injection rates for the proposed recirculation system are not expected to create significant mounding. Design studies will be conducted to optimize the location and operation of the system.

6. Monitored Natural Attenuation (MNA) of groundwater in conjunction with source area treatment is appropriate and consistent with The OSWER Directive for Monitored Natural Attenuation. MNA should be considered in the design of source area treatment. Reduction in source area concentrations will result in decreases in the downgradient groundwater impact. The plume appears to be relatively stable at this time and a reduction of mass influx should be apparent relatively soon.

Response: The Selected Remedy includes monitored natural attenuation for site-wide groundwater treatment. Based on the monitored natural attenuation groundwater data collected at and

immediately downgradient of the Beall Source Area, monitored natural attenuation is not a viable option for remediation in that area. The chlorinated solvents in the groundwater plume are not attenuating naturally in or immediately downgradient of the Beall Source Area. Therefore, the Selected Remedy includes active source remediation and groundwater control and remediation for the Beall Source Area to ensure complete remediation of those areas.

Commenter #8:

1. The Brenntag and the Beall facilities should be designated as separate operable units with separate records of decision.

Response: DEQ and EPA will not issue separate Records of Decision. While it is technically feasible to separate most of the remedial components between the two source areas, the contaminated groundwater is present contiguously throughout the entire site. Such a separation is not necessary for administrative purposes at this time. DEQ and EPA believe more efficient and coordinated progress towards remediation will occur under one remedial decision for the site. DEQ and EPA do not oppose discussing a division of responsibilities between the Responsible Parties during Consent Decree negotiations.

2. Brenntag endorses certain approaches included in the Preferred Alternative, but proposes important modifications to the remedial technologies proposed for the Brenntag Source Area. Enhanced bioremediation downgradient of the Brenntag Source Area may increase risks to human health and should not be included in the final remedy. Brenntag proposes a modified version of the Preferred Alternative for the Brenntag Source Area to include some combination of air sparge, ozone sparge, and soil vapor extraction for source soil remediation. They also propose groundwater containment and remediation and eliminate enhanced bioremediation for downgradient groundwater.

Response: The Selected Remedy represents the best alternative based on a comparative analysis consistent with the nine criteria identified in the Feasibility Study (TtEMI 2004). To address any site-related risk to human health, the Selected Remedy includes excavation of vadose soils up to 14 feet below ground surface, to include the silty sand layer that may impede Brenntag's proposed soil vapor extraction system. The Selected Remedy also contains several components whose final design will be determined during Remedial Design. For example, the Selected Remedy includes enhanced bioremediation and further evaluation of the appropriate method of enhanced bioremediation will ensure the complete treatment of vinyl chloride. DEQ and EPA selected permanganate as the oxidant based on the strength of the oxidant in consideration of the concentrations of contaminants in the source areas. However, the specific oxidant could be refined during Remedial Design. To intercept any contaminants migrating from the source area in groundwater, a treatment wall has been selected; the specific technology will be determined with design studies.

3. An independent monitoring program should be developed for the Brenntag Source Area during the Remedial Design phase. The monitoring program described in the Feasibility Study should not be used as part of the remedy for the Brenntag Source Area.

Response: The Feasibility Study (TtEMI 2004) included a generic monitoring program that could be consistently applied to each alternative. It is not the intent of the Feasibility Study nor is it practical to design a specific sampling program for each alternative. A specific monitoring program for the entire site will be developed during Remedial Design.

Commenter #8 – Appendix 1 (Additional Comments):

1. The Preferred Alternative includes excavation of vadose zone soil in the northwest Brenntag Source Area. In the Feasibility Study, excavation is proposed at all portions of the Brenntag Source Area from the ground surface “to the bottom of the fine-grain silty sand unit, an estimated average of 14 feet bgs.” Because the vadose zone is approximately 5 feet thick in the northwest area of the Brenntag site, these two specifications of the proposed depth of excavation are in conflict.

Response: Sampling data indicate that contamination is present above soil cleanup levels throughout the shallow fine-grain unit at Brenntag (Figures 2-2 and 2-5, TtEMI 2004). This unit extends from the vadose zone into the saturated zone. For the purposes of the Feasibility Study (TtEMI 2004), DEQ and EPA chose an average depth of 14 feet below ground surface for the thickness of this contaminated soil and for estimating cost consistently for each alternative. The accessible portion of this fine grain unit will be excavated under the Selected Remedy, including portions above and below the water table. Inaccessible portions of this contaminated soil layer will be remediated with soil vapor extraction in the vadose portion and by in-situ chemical oxidation in the saturated zone. More specific excavation and treatment depths will be determined during Remedial Design.

2. The Preferred Alternative includes on-site thermal treatment of the vadose zone soil that would be excavated in the northwest Brenntag Source Area. Land farming is discussed as a form of ex-situ biological treatment, but this option is eliminated at the technology screening step in the Feasibility Study. Although the Feasibility Study indicates land farming could be moderately difficult to implement due to space limitations, there is sufficient land area available at Brenntag to allow implementation of this technology. Brenntag believes that land farming should be considered as a treatment option for any contaminated soils that are excavated at the Brenntag Source Area. Ex-situ SVE should also be considered as a treatment option for any contaminated soils that are excavated.

Response: Land farming was eliminated from further consideration in the Feasibility Study (TtEMI 2004) for multiple reasons. While information on the success of land farms for chlorinated solvents is limited, land farms in general for other types of contaminants, are less effective and require more time to reach remediation goals in colder climates, as biological activity can be significantly reduced during the winter and treatment is not as effective. The Feasibility Study determined that the cost of implementing an ex-situ land farm system to remediate contaminated soil is moderate to high due to the need to operate an engineered treatment facility for a long period of time. Additionally, the Feasibility Study did not consider ex-situ land farming of contaminated soil further because of uncertainty if land farming can meet remediation goals. The Feasibility Study determined that other treatment options provide greater effectiveness, as discussed during a September 30, 2004, meeting between representatives of DEQ, EPA, and Brenntag. At the September 30 meeting, DEQ and EPA offered Brenntag the opportunity to provide examples of successful implementation at specific Superfund sites, with details of the land-farm design, effectiveness, performance monitoring results, and community acceptance, for reevaluation of this option. Brenntag did not provide the requested information. Land farming is not a proven, readily acceptable remedy for chlorinated solvent compounds. DEQ and EPA also eliminated ex-situ soil vapor extraction from further consideration based on similar issues. Thermal treatment allows for control of air emissions, both odor and potentially harmful byproducts, is complete in one construction season (not years as would be expected in a land-farm), and is a proven technology as EPA’s presumptive remedy for treatment of VOC contaminated soil.

3. The list of common elements to be included in all remedial alternatives is not consistent throughout the Feasibility Study and the Proposed Plan. For example, Section 5.1.1 of the

Feasibility Study lists three common elements (long-term monitoring, five-year reviews, and institutional controls) and provides details for each. In Section 6, however, the descriptions of the alternatives list a fourth common element, continued risk mitigation measures, without specifying what these measures include. A similar inconsistency is noted in the Proposed Plan, where the common elements are listed as institutional controls, long-term monitoring, and continued risk mitigation measures; in this case, five-year reviews are listed separately.

Response: All remedial alternatives, except for No Further Action, include the following common elements: 1) long-term monitoring; 2) CERCLA 5-year reviews; and 3) Institutional Controls. Institutional Controls as detailed in Section 5.1.1 of the Feasibility Study (TtEMI 2004) include land use controls, groundwater use restrictions, educational programs, and site administrative procedures (such as continued risk mitigation measures). Therefore, the common elements are essentially the same in the Feasibility Study and the Proposed Plan. The Selected Remedy includes clarification and details of the retained common elements.

4. Air or ozone sparging in combination with SVE is considered as a technology option in the Feasibility Study, but only Alternative 5 involves application of this technology at the Brenntag Source Area. Furthermore, Alternative 5 applies this technology as a barrier to downgradient migration of contaminated groundwater but not as a Remedial Action for contaminated soils and groundwater in the Brenntag Source Area. Integrated sparging and SVE systems are capable of treating contaminated soil above and below the water table as well as contaminated groundwater. An alternative that involves application of such integrated systems at the Brenntag Source Area should have been developed and evaluated in the Feasibility Study.

Response: DEQ and EPA recognize additional combinations of options are available; however, every possible combination of available remedial options cannot be evaluated in a Feasibility Study. Therefore, DEQ and EPA selected those alternatives most representative of the options available for remediation at the site to be evaluated in the Feasibility Study. The ability of air sparging and soil vapor extraction to meet Remedial Action Objectives in a reasonable timeframe is dependent upon the nature and extent of contaminant source material. The presence of large quantities of NAPL-contaminated soil may significantly extend remediation timeframes. NAPL-contaminated soil has been found at the Brenntag Source Area in both the vadose and saturated zones. Air sparging can cause groundwater mounding that could potentially accelerate or alter plume migration. Therefore, air or ozone sparging in the Brenntag Source Areas was not further developed in the Feasibility Study. At the northwest Brenntag Source Area, DEQ has identified a silty sand layer that is a potential impedance to Brenntag's proposed soil vapor extraction system in the source area. The Selected Remedy includes excavation of vadose soils up to 14 feet below ground surface in the northwest Brenntag Source Area, which includes this silty sand layer. Excavation and thermal treatment is a proven technology as EPA's presumptive remedy for treatment of VOC contaminated soil.

5. Brenntag believes that the soil and groundwater data collected in the northwest source area suggest that chemical impacts extend through the sandy gravel section to bedrock, and that these saturated zone impacts can be effectively remediated by ozone sparging. The Feasibility Study states that "the preferred oxidant would be sodium or potassium permanganate," and that "ozone air sparging is considered in the groundwater alternatives." There is no apparent reason for selecting permanganate injection rather than ozone sparging in alternatives 6, 7, and 8. As noted in Section 7.6, most of the technologies included in the alternatives will require site-specific pilot or design studies in order to maximize their effectiveness. Brenntag believes that the remedial technologies to be used should be selected during Remedial Design, and that a phased approach involving the sequential application of multiple technologies (if necessary) would be most effective.

Response: DEQ and EPA selected permanganate as the oxidant because it is a stronger oxidant to remediate the high concentrations of contaminants in the source areas and to provide consistent cost estimates throughout the Feasibility Study (TtEMI 2004). However, the specific oxidant could be refined during Remedial Design based on pilot test results. DEQ and EPA considered a phased approach and determined it was not practical due to the administrative and technical difficulty in defining and enforcing objectives that would dictate a move to the next technological approach. A phased approach would also extend the time necessary to remediate the site.

6. Costs provided in the Feasibility Study for the installation of a permeable reactive barrier at the Brenntag Source Area are about 56% of the vendor quote. When all of the contingency, project management, and other costs are included, the cost difference is approximately \$1.1 million. This change nearly doubles the cost of the permeable reactive barrier and raises the estimated cost of the Preferred Alternative to \$15.4 million.

Response: The Feasibility Study (TtEMI 2004) consistently estimated costs of the remedial alternatives on information provided through Remedial Action Cost Engineering and Requirements. EPA's guidance (EPA 2000) explains cost estimates made during the Feasibility Study are expected to provide an accuracy of +50 percent to -30 percent. The cost difference noted above is within the bounds of Feasibility Study expectations. DEQ and EPA recognize all the costs included in the Feasibility Study are based on 2003 data; therefore, all costs would incrementally increase if reevaluated in 2005 and would not affect the overall comparison values of the costs.

7. The unit cost of the granular iron material that would be used in the permeable reactive barrier has fluctuated over a wide range since the vendor quote in Appendix F of the Feasibility Study was obtained. The current (January 2005) unit cost estimate from the same vendor is \$800/ton delivered, and the unit cost last fall was as high as \$1,050/ton delivered. A unit cost of \$800/ton for granular iron would increase the cost of the Preferred Alternative to about \$16.4 million (\$1 million over the corrected estimate in the preceding comment).

Response: The Feasibility Study (TtEMI 2004) consistently estimated costs of the remedial alternatives on information provided through Remedial Action Cost Engineering and Requirements. EPA's guidance (EPA 2000) explains cost estimates made during the Feasibility Study are expected to provide an accuracy of +50 percent to -30 percent. The cost difference noted above is within the bounds of Feasibility Study expectations. DEQ and EPA recognize all the costs included in the Feasibility Study are based on 2003 data; therefore, all costs would incrementally increase if reevaluated in 2005 and would not affect the overall comparison values of the costs.

8. In discussing SVE as a remedial option for soil, the Feasibility Study states that the pilot studies conducted at Brenntag have not generated specific design parameters for this technology. The earlier Brenntag pilot study (as described in Appendix B of the Feasibility Study [TtEMI 2004]) addressed the feasibility of ozone sparging as a groundwater remediation technology. As explained in detail in the SVE pilot test report included with these comments, recent experience with the vapor extraction portion of the OS/SVE system installed at the northwest Brenntag Source Area indicates that soil vapor extraction is an appropriate technology for remediation of the vadose zone soil in this area.

Response: DEQ and EPA did not have the information presented with these comments at the time of the Feasibility Study. However, this information and additional information collected through pilot studies can be used to design components of the Selected Remedy provided the requirements of the Selected Remedy are maintained.

9. The source areas considered for remediation at the Brenntag Source Area are defined by comparing the soil sampling results to the remediation goals provided in Table 4-2 of the

Feasibility Study. The remediation goals are derived for vadose zone soils using mathematical models described in Appendix D (for the vadose zone) and Appendix E (for the groundwater) of the Feasibility Study. Application of these models to represent conditions at the Brenntag Source Area requires the specification of values for numerous model parameters. Some of the parameter values selected may be more conservative (more likely to result in low remediation goals) than necessary to protect public health and the environment, and should be reconsidered.

Response: DEQ developed Preliminary Remediation Goals for soil using site-specific data and modeling when site data was not available. The modeling conducted as part of the Feasibility Study (TtEMI 2004) follows EPA's guidelines (EPA 1996) for determining soil cleanup levels. It is the goal of DEQ and EPA to provide conservative remediation goals in order to ensure the protection of human health and the environment. The Selected Remedy is no more conservative than is necessary to protect the citizens of Lockwood,

10. The volume of contaminated soil used in evaluating the various alternatives for the Brenntag Source Area was calculated by identifying the suspected areas of soil contamination, then assuming that this contamination extends from the ground surface to the bottom of the fine-grained section. For the Brenntag Source Area, an average depth of 14 feet was assumed. If, as suggested by some of the data, contaminated soils actually extend into the sand and gravel unit, the cost of excavation may be significantly greater than the estimates provided in the Feasibility Study. As noted in Section 4.2.7, excavation below the water table or to depths greater than about 15 feet may require specialized equipment and/or containment and treatment of groundwater. The cost estimates provided in the Feasibility Study for the alternatives that involve excavation of contaminated soils do not appear to include allowances for these factors.

Response: DEQ and EPA recognize numerous contingencies may be encountered for each alternative; however, every possible contingency cannot be evaluated in a Feasibility Study. Design studies and further soil sampling will assist with evaluation of such contingencies during Remedial Design.

TABLES

FIGURES

APPENDIX A

Cost Estimate for the Selected Remedy

APPENDIX B

Final Determination of ARARs

APPENDIX C

Revised Soil Cleanup Level Modeling